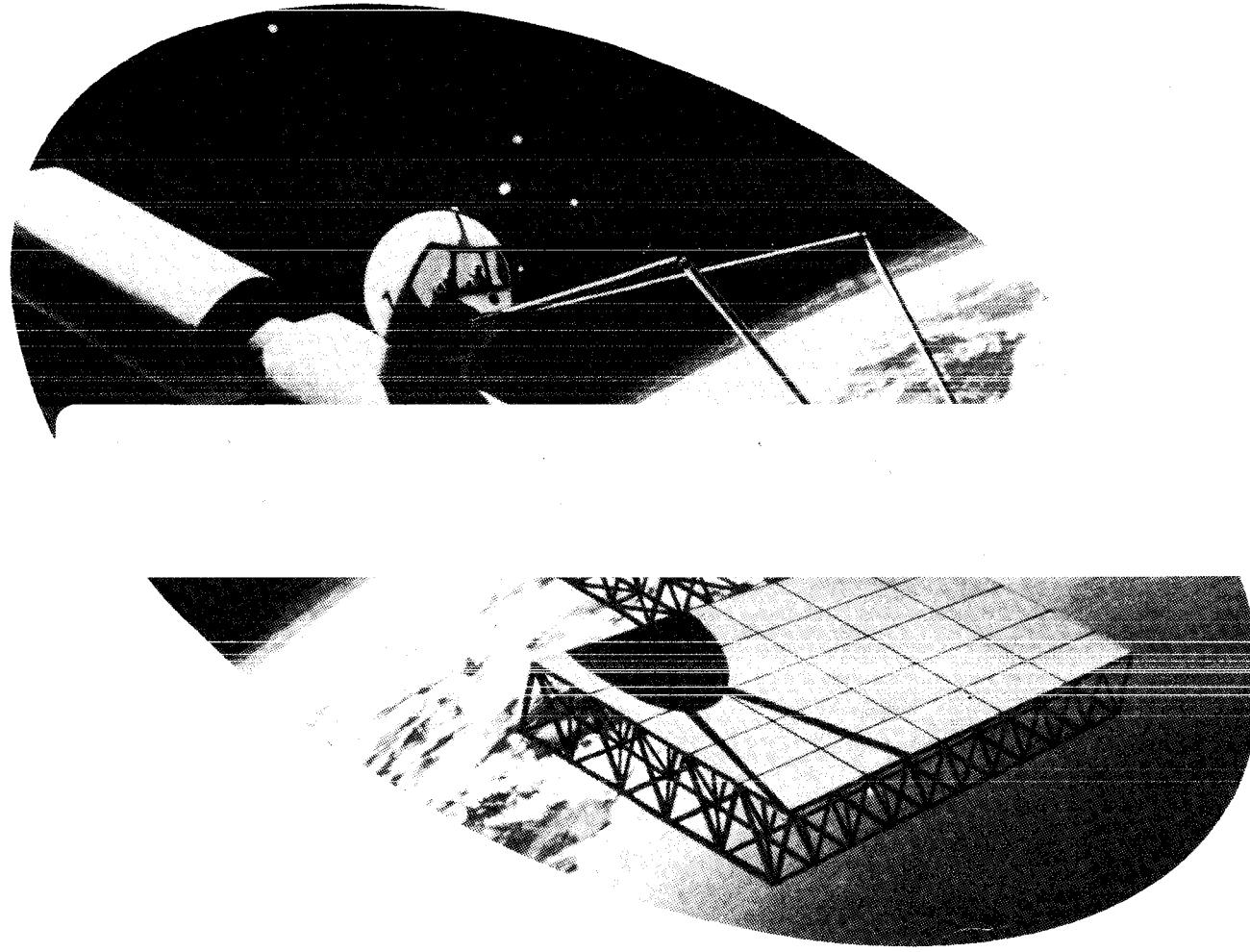


IN-SPACE RESEARCH, TECHNOLOGY AND ENGINEERING (RT&E) WORKSHOP

VOLUME 8 OF 8

IN-SPACE OPERATIONS



NATIONAL CONFERENCE CENTER

WILLIAMSBURG, VIRGINIA

OCTOBER 8-10, 1985



National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23665



Office of Aeronautics
and Space Technology
Washington, DC

NOTICE

The results of the OAST Research, Technology, and Engineering Workshop which was held at the National Conference Center, Williamsburg, Virginia, October 8-10, 1985 are contained in the following reports:

- VOL 1 Executive Summary
- VOL 2 Space Structure (Dynamics and Control)
- VOL 3 Fluid Management
- VOL 4 Space Environmental Effects
- VOL 5 Energy Systems and Thermal Management
- VOL 6 Information Systems
- VOL 7 Automation and Robotics
- VOL 8 In-Space Operations

Copies of these reports may be obtained by contacting:

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IN-SPACE OPERATIONS

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FOREWORD

Within NASA, the Office of Aeronautics and Space Technology (OAST) has the responsibility for timely development of needed new technologies. Traditionally, the development of new concepts, new materials, designs, and engineering techniques for aeronautics has been accomplished in close cooperation with the aircraft industry and with the great American universities. On the other hand, NASA, as the primary user of space flight, has been its own principal customer for new space technologies.

A new era of permanent presence in space is beginning with the Space Station. This permanent presence will permit and promote commercial ventures and privately funded research in the tradition of university/industry cooperation.

The RT&E workshop in Williamsburg represents a significant milestone for NASA and the space engineering community. It marked the initiation of a long-term program of outreach by NASA to focus the needs of universities, industry, and government for in-space experiments and to begin building a strong national user constituency for space research and engineering.

These proceedings represent a "first-cut" planning activity to involve universities, industry, and other government agencies with NASA to establish structure and content for a national in-space RT&E program. More interactions are needed - more workshops will follow. Program adjustments will be made. A truly national program will evolve, and its beginnings are presented here with the hope and determination needed to make it a program we can all take pride in.

- Raymond Colladay

INTRODUCTION

Among the purposes of the Research, Engineering, and Technology Workshop, an interest in validating the RT&E theme concept has some direct effect on the form of these proceedings. The original five themes, which were themselves a target for validation or recommended changes, have become seven. During preparations for the workshop, the submitted papers and attendance plans made it evident that the fifth "theme", In-space Operations, was too broad, and would need to be split. As the workshop got underway, a further split occurred, brought about by the different levels of maturity, and needs for technology planning in several sub-disciplines. Thus, these proceedings are presented under seven themes. The volume of presentations, and the quantity of information generated by the individual panel summaries has led to the decision to prepare the proceedings in several volumes.

The first volume is an executive summary and includes the summary presentations made by the panel co-chairmen in the final plenary session. The accompanying seven volumes, of which this is one, each represent a specific "theme", and include the un-edited original presentation material used in that particular panel workshop. Each of these separate "theme" volumes also include the Foreword, the general Summary and Conclusions, and the Chairman's presentation charts and narrative summary. Thus, each should represent a self-standing volume to reflect the proceedings relevant to its respective Panel deliberations and output, as well as the reflection in the general Workshop results.

WORKSHOP THEME

In-Space Operations

- Advanced Life Support Systems
- Biomedical Research
- Tethers
- Maintenance and Repair
- OTV
- System Testing
- Propulsion
- Material Processing

SUMMARY AND CONCLUSIONS

NASA's In-Space Research, Technology, and Engineering (RT&E) Workshop brought together representatives of the university community, private sector, and government agencies to discuss future needs for in-space experiments in support of space technology development and the derivative requirements for space station facilities to support in-space RT&E.

The workshop provided an excellent forum for establishing an interactive process for building a national in-space experiments program. It enabled NASA to present to the user community (university and private sector) experiment concepts for NASA's technology development activities in support of future space missions. The meetings also began a process by which industry and university researchers will be able to bring their own TDM requirements to NASA's planning process.

This conference reached three primary goals: first, it expanded and validated NASA's in-space experiment theme areas, including Space Structure (Dynamics and Control), Space Environmental Effects, Fluids Management, Energy Systems and Thermal Management, Automation and Robotics, Information Systems and In-Space Operations; second, it began the development of a user community network which will interface with NASA throughout the lifetime of the in-space experiment program; and third, it formed the basis for the establishment of on-going working groups which will continue to interest and coordinate requirements for in-space RT&E activities.

As an adjunct to the conference, NASA/OAST announced plans to initiate a long-term program to encourage and support industry and university experiments. NASA's modest investment in this program is initially targeted for generating experiment

ideas and concepts. It is anticipated that this base of concepts will lead to cooperatively funded experiments between NASA, industry, and academia and thereby, begin to build an active in-space RT&E program.

Several key points emerged from this conference regarding the adequacy of the TDM data base that should be addressed in future planning activities. First, many of the experiments could be performed on the ground, i.e., they do not justify a space experiment. Secondly, many of the experiments address near-term or current applications and do not take into account advanced system requirements. The TDM data base must look beyond extensions of current programs to reflect future needs and trends to have an effective and useful impact on space station planning and design. This will require increased input from industry and university researchers and engineers.

In order to address these concerns, it is imperative that a long-range planning view be taken in which industry and university researchers help NASA derive the technology development program. The following recommendations have been developed on the basis of the workshop:

1. Development of an on-going RT&E university and industry advisory group;
2. Continuation of in-space RT&E symposia to act both as outreach mechanisms and as working sessions to refine the TDM data base;
3. Development of an RT&E information clearinghouse;
4. Development and continuation of the new experiments outreach activity announced at the RT&E workshop;
5. Development of an "impacts assessment group" which will focus its energy on identifying experiment accommodation requirements to impact the design of in-space facilities, i.e., space station and others.

If carried out, these recommendations constitute movement toward development of an effective NASA/industry/university partnership in a National In-Space RT&E Program. This will also enable NASA/OAST to have an effective voice in space station planning, which is essential toward the success of a future in-space activities. The workshop, by promoting the process of NASA/industry/university interactions and by pointing out concerns with the developing TDM data base has provided an important first step towards a successful long-term space technology development effort.

IN-SPACE RESEARCH, TECHNOLOGY, AND ENGINEERING WORKSHOP

IN-SPACE OPERATIONS

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JIM LOOS	LMSC	MEMBER
CAPT. JOSEPH P. NICHOLAS	HQ USAF/TXOS	MEMBER
RICHARD A. RUSSELL	LARC	EX-OFFICIO
WILLIAM McALLUM	LARC	EX-OFFICIO

5/18

560 425

20

IN-SPACE OPERATIONS SUMMARY Harold Compton

The In-Space Operations panel was chartered to receive and evaluate TDM proposals in the five areas of:

Advanced Life Support Systems (ALSS)

Tethers

Orbital Transfer Vehicles (OTV)

Systems Testing

Propulsion

The panel received twenty-four proposals and, in order to accommodate proposals that did not clearly fit into one of the above areas, the theme areas were expanded to eight to include maintenance and repair, bioresearch, and materials processing. In keeping with the workshop objective, the proposals were categorized as to research, technology, or engineering. Three of the proposals, one in bioresearch and two in materials processing, were considered science and applications, and two were considered inappropriate as TDMs.

The proposals addressed significantly more than the IOC space station. Their requirements for in-space measurements/capability included shuttle and/or free flyers tended by shuttle, build-up or man-tended space station, IOC space station, and growth space station and beyond. Thus the proposals were prioritized as follows:

1 Needed for space station phase C/D

- Precursor shuttle TDM

2 Needed prior to IOC station

- Needed prior to IOC station
- Check-out and build-up phase TDM

3 Needed for growth station and beyond

- Post IOC TDM

4 Enhances operations or capabilities

- A. Station
- B. Other than station

and annotated according to in-space requirements. It should be noted that some of the proposals required multiple in-space capability, i.e., were shuttle and space station applicable.

In the evaluation of the TDM proposals, the panel noted a common thread, the requirement for a separate and unique research facility, throughout the presentations. These requirements included a propulsion, biomedical research, variable gravity, human research, and space test and evaluation facility. The panel also noted the lack of advanced closed loop environmental life support system (CLESS) TDMs and suggested that such proposals be solicited. The biomedical research TDMs had little in common with in-space operations.

The panel determined that the proposed TDMs have the potential for significant impacts on the space station. Some of the proposals such as the propulsion facility would in themselves produce a contaminated environment. The requirement for a micro or near

zero gravity facility might necessitate a free flyer possibly tethered to the station. Large total in-space mass requirements, 40,764 KG alone in 1993, and large power requirements, as much as 35KW for a single experiment, were proposed for the station. Extra vehicular activity (EVA) was found to be modest, but inter-vehicular activity (IVA) was significant, six man years in 1992 alone. Significant scarring of the IOC station will likely be required for OMV and OTV servicing and payload mating facilities.

The panel recommended continuing workshop activity for the advocacy and development of appropriate in-space RT&E TDMs. Perhaps one workshop per year would be sufficient. In any case, the workshop management should emphasize and better define for potential experimenters the TDM concept and the potential RT&E facilities. Advocacy for more DoD involvement should be developed, and a clearing-house activity should be instituted for integrating and coordinating the TDMs. The panel also recommends RT&E experiments advisory committee, co-chaired by OAST and OSS, with representation from DOD, DOE, DOT, SDIO, ACADEMIA, and INDUSTRY. Finally, the panel recommend publication of workshop proceedings or summaries.

IN-SPACE OPERATIONS B

IN-SPACE RESEARCH, TECHNOLOGY, AND ENGINEERING WORKSHOP

Paul Bialla – GDC Harold Compton – NASA

**Williamsburg, Virginia
October 8–10, 1985**

IN-SPACE OPERATIONS - B

PAUL BIALLA - CO-CHAIRMAN	GDC
HAROLD COMPTON - CO-CHAIRMAN	OAST
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BARNEY ROBERTS	JSC
DONALD SIMKIN	RI
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CAPT. JOSEPH P. NICHOLAS	HQ USAF/TXOS
RICHARD A. RUSSELL - EX-OFFICIO	LARC
WILLIAM McCALLUM - EX-OFFICIO	LARC

TDM SUMMARY

RECEIVED 24 TDM PROPOSALS

- o 2 LIFE SUPPORT
- o 2 TETHER
- o 3 OTV
- o 3 PROPULSION
- o 3 SYSTEM TEST
- o 5 MAINTENANCE & REPAIR
- o 4 BIORESEARCH
- o 2 MATERIAL PROCESSING

3 WERE CONSIDERED SCIENCE & APPLICATIONS ORIENTED

- o 1 BIORESEARCH
- o 2 MATERIAL PROCESSING

2 WERE CONSIDERED INAPPROPRIATE AS TDMS

- o 2 SYSTEM TEST

OBSERVATIONS

- PRESENTATIONS ADDRESSED MORE THAN IOC STATION
- PRESENTATIONS FALL INTO DISTINCT CATEGORIES
 - TECHNOLOGY DEVELOPMENT
 - BASIC RESEARCH
 - CONCEPT DEMONSTRATION/PROOF OF CONCEPT
 - VERIFICATION AND CERTIFICATION
- PRESENTATIONS REQUIRE DIFFERENT IN-SPACE CAPABILITIES
 - SHUTTLE/FREE FLYERS TENDED BY SHUTTLE
 - SPACE STATION; BUILD-UP
 - SPACE STATION; IOC
 - SPACE STATION; GROWTH
- MANY TDM'S REQUIRE OTHER TDM'S AS PRECURSORS
 - ALL PRECURSORS HAVE NOT BEEN IDENTIFIED
 - NEED BOOKKEEPING METHOD TO KEEP TRACK OF SUPPORTING TDM'S

DEFINITION OF PRIORITIES AND CATEGORIES

o PRIORITIES

1. NEEDED FOR SPACE STATION PHASE C/D
 - PRECURSOR SHUTTLE TDM
2. NEEDED PRIOR TO IOC
 - PRECURSOR SHUTTLE TDM OR
 - CHECK-OUT AND BUILD-UP PHASE TDM
3. NEEDED FOR GROWTH STATION AND BEYOND
 - POST IOC TDM
4. ENHANCES OPERATIONS OR CAPABILITIES
 - A. STATION
 - B. OTHER THAN STATION

o CATEGORIES

- R = RESEARCH, BASIC OR APPLIED
- T = TECHNOLOGY DEVELOPMENT
- E = DEMONSTRATION OF ENGINEERING, CONCEPT, TESTING, OR VERIFICATION

IN-SPACE OPERATIONS - B
PROPELLSION

TDM DESCRIPTION	CATEGORY	PRIORITY	SHUTTLE	SS - BU	SS - IOC	SS GROWTH	COMMENTS	
							FACILITY	
TDM _____ - LOW THRUST PROP. TECH.	T	4A,B	X	X	X	X	A PROPOSAL FOR A TEST FACILITY. COULD BECOME PRIORITY - 1.	
TDM 2322 - LASER PROPELLION	T	4B	X	X	X	X	PART OF THREE OTHER TDMS	
TDM _____ - ION PROPELLION	E	4B	X				SCHEDULED ON A SHUTTLE FLIGHT IN 1986 -	
TDM _____ - HIGH ISP ION PROPELLION							NOT PRESENTED	
TDM _____ - MPD THRUSTER							NOT PRESENTED	
							THESE 5 TDMS SUGGEST A PROPELLION LABORATORY HAS HIGH VALUE - PLUME RESEARCH FACILITY ALSO?	

IN-SPACE OPERATIONS - B
 OTV

TDM DESCRIPTION	CATEGORY	PRIORITY	SHUTTLE	SS - BU	SS - IOC	SS GROWTH	FACILITY	COMMENTS
TDM-2573 - OTV PROX. OPS	T,E	+3	X	X	X			THESE THREE TDMS AS PROPOSED ARE A MIXTURE OF TECHNOLOGY DEVELOPMENT AND PROCEDURES DEVELOPMENT. TECHNOLOGY DEVELOPMENT TDMS ARE NEEDED EARLIER IN ORDER TO SUPPORT THE OTV DEVELOPMENT SCHEDULE.
TDM-2574 - OTV MAINTENANCE	T,E	+3	X	X	X	X		- OMV REQUIRED -
TDM-2571 - OTV INTERFACING AND TRANSFER	T,E	+3	X	X	X	X		

IN-SPACE OPERATIONS - B
TETHERS

TDM DESCRIPTION	CATEGORY	PRIORITY	SHUTTLE	SS - BU	SS - IOC	SS GROWTH	COMMENTS	
							FACILITY	
TDM _____ - TETHERED CONSTELLATION	T,E	4A	X	X	X	X	THESE TWO TDMS WERE PROPOSED AS OPERATIONAL SYSTEMS - NOT TDMS - WE NEED TO HAVE "REAL" TDMS FOR TETHER DEVELOPMENT	
TDM _____ - TETHERED TRANSPORTATION	T,E	4A	X	X	X	X		

IN-SPACE OPERATIONS - B
 SYSTEMS TESTING

TDM DESCRIPTION	CATEGORY	PRIORITY	SHUTTLE	SS - BU	SS - IOC	SS GROWTH	COMMENTS
TDM - STEF - SPACE TEST & EVAL. FACILITY	E	4B	x	x	x	x	NOT REALLY A TDM BUT A PROCESS TO IDENTIFY THE REQUIREMENTS FOR TEST AND RESEARCH FACILITIES.
TDM - VARIABLE G EXP. FACILITY							A RESEARCH FACILITY - REQUIRED FOR VEHICLE DESIGN AND HUMAN SPACE ADAPTATIONS FOR MARS AND LUNAR MISSIONS. HIGHLY DESIRABLE FOR OTHER RESEARCH.
TDM - AUTOMATIC SATELLITE C/O EQUIPMENT	E		x				NEEDS ADVOCACY FOR SHUTTLE, MANDATED FOR STATION

IN-SPACE OPERATIONS - B
ADVANCED LIFE SUPPORT

TDM DESCRIPTION	CATEGORY	PRIORITY	SHUTTLE	SS - BU	SS - IOC	SS GROWTH	COMMENTS	
							FACILITY	
TDM _____ - CONTAMINANT ANALYSIS	T,E	1	X	X			DEMONSTRATION AND CERTIFICATION OF SPACE STATION CONTAMINATION MONITOR & ATMOSPHERIC PREDICTION MODEL - SPACE STATION SUPPORT?? REQUIRED FOR IOC??	
TDM _____ - FIRE SAFETY	T	1	X	X	X		BEGIN W/SHUTTLE TESTS - CONTINUE ON STATION - DEVELOP SAFETY DATA BASE FOR STATION.	

IN-SPACE OPERATIONS - B
BIOMEDICAL RESEARCH

TDM DESCRIPTION		FACILITY	COMMENTS			
CATEGORY	PRIORITY	SHUTTLE	SS - BU	SS - IOC	SS GROWTH	
TDM _____ - DEVELOPMENT OF A BIOREACTOR	T,R	4B	X	X	X	SHOULD EVOLVE OR BE A PART OF A HUMAN RESEARCH FACILITY - ? SHOULD THIS BE SCIENCE AND APPLICATIONS
TDM _____ - SURGERY TECHNOLOGY	R	4A,B		X	X	REQUIRES OPERATIONAL HMF
TDM _____ - MEDICAL EXPERIMENTS TECHNOLOGY	R	4A,B		X	X	REQUIRES HUMAN RESEARCH FACILITY AND MAY REQUIRE THE HMF
TDM _____ - CANDIDATE MANNED SYS. EXP.	T	4A,B	X	X	X	A SET OF EXPERIMENTS FOR A HRF - AS PROPOSED, ONLY REQUIRES THE HMF - EQUIPMENT DEVELOPMENT ON SHUTTLE - ALSO INCLUDES QUARTERS MAINTENANCE AND OPERATIONS - HUMAN FACTORS. IT IS VERY DESIRABLE TO PERFORM SOME EXPERIMENTS ON THE SHUTTLE.

IN-SPACE OPERATIONS - B
MAINTENANCE AND REPAIR

TDM DESCRIPTION	CATEGORY	PRIORITY	SHUTTLE	SS - IOC	SS GROWTH	COMMENTS
TDM-2581 - SYSTEMS OPERATIONAL MAINTENANCE	E	4A	X	X	X	THE PROPOSED TDM IS NOT CLEAR - IT DOES TELL US THAT WE NEED A FACILITY FOR MAINTENANCE TECHNOLOGY DEVELOPMENT AND ENG. DEV.
TDM-2561 - SATELLITE MAINTENANCE AND REPAIR	E	4A	X	X	X	OMV REQUIRED - MANY TDM PRECURSORS REQUIRED FOR TECHNOLOGY DEVELOPMENT - THIS AND TDM 2563, ARE ENGINEERING VERIFICATION & PROOF OF CONCEPT
TDM-2563 - MATERIALS RESUPPLY	E	4A	X	X	X	OMV W/KITS REQUIRED - PRECURSORS REQUIRED.
TDM-2564 - COATING MAINTENANCE AND REPAIR	T	3	X	X	X	DEMONSTRATE INSTRUMENT ON SHUTTLE; OPERATIONAL AS EARLY AS POSSIBLE - IMPACT GROWTH STATION.
TDM _____ - ON-ORBIT WELDING	T	4A	X	X	X	CURRENT PLANS ARE FOR A SHUTTLE TEST - SOME FOLLOW-ON TESTING COULD BE DONE ON SPACE STATION.

IN-SPACE OPERATIONS - B
MATERIAL PROCESSING TDMS

TDM DESCRIPTION	CATEGORY	PRIORITY	SHUTTLE	SS - BU	SS - IOC	SS GROWTH	COMMENTS
FACILITY							
TDM _____ - CRYSTAL GROWING							THIS TDM IS TO FIRST DO SOME TECHNOLOGY DEVELOPMENT, BUT IS MOSTLY PROOF OF CONCEPT.
TDM _____ - FLUIDIZED BED							SUPPORTS MATERIALS PROCESSING IN SPACE AND ON OTHER PLANETARY SURFACES

FINDINGS

- o TDMS ARE "FALLING" INTO GROUPS THAT ARE MAKING SEVERAL RESEARCH AND TEST FACILITIES VIABLE OPTIONS

- PROPULSION RESEARCH FACILITY
 - o THRUSTER RESEARCH
 - o FLUID HANDLING & TRANSFER
 - o PLUME AND CONTAMINATION MEASUREMENT
- BIOMEDICAL RESEARCH FACILITY
 - TETHER DEVELOPMENT AND PROOF OF CONCEPT
 - VARIABLE G RESEARCH FACILITY
 - HUMAN RESEARCH FACILITY
 - SPACE TEST AND EVALUATION FACILITY (?) (?)
- o MISSING
 - ADVANCED CELSS TECHNOLOGY DEVELOPMENT
 - o NEED CELSS RESEARCH FACILITY
 - TDM ENGINEERING DEMO OF OMV
- o EXTRA - BIOMEDICAL RESEARCH
 - HUMAN MEDICAL RESEARCH
 - HUMAN FACTORS RESEARCH
 - BIOREACTOR

SPACE STATION IMPACTS

- CONTAMINATION ENVIRONMENT - RESOLUTION: FREE FLYER
- ACCELERATION ENVIRONMENT - RESOLUTION: FREE FLYER
- LARGE MASSES (1993: 40,764 KG)
- POWER REQUIREMENTS CAN BE HIGH
 - AS MUCH AS 35 KW FOR SINGLE EXPERIMENT
- SHORT DURATION - ENERGY STORAGE TECHNIQUES MAY RESOLVE
- EVA IS MODEST BUT NOT NEGIGIBLE
- IVA IS SIGNIFICANT - 1992 - 6 MAN YEARS
- OMV AND OTV UTILIZATION IS MODEST
- SIGNIFICANT "SCAR" MAY BE REQUIRED
 - FOR FACILITIES

RECOMMENDATIONS

- o DEVELOP A FORMALIZED SYSTEMS APPROACH TO TDM DEFINITIONS
 - INVITED PAPERS DOES NOT ENSURE COMPLETENESS
 - GOVERNMENT/INDUSTRY/UNIVERSITY ADVISORY GROUP
- o WORKSHOP SHOULD CONTINUE BUT SHIFT IN EMPHASIS
 - CONCEPT DEVELOPMENT
 - PLANNING (DOCUMENT)
 - PRIORITIZING
 - INTEGRATION AND COORDINATION
- o IMPROVE DOD INVOLVEMENT
- o DEVELOP DEFINITION OF RT&E FACILITIES

RECOMMENDATION FOR CONTINUING ACTIVITY

- o NEED
 - CLEARING HOUSE ACTIVITY FOR TDMS
 - INTEGRATING AND COORDINATING FOCAL POINT
 - A MANAGEMENT AND PLANNING MECHANISM FOR OAST
 - IMPACTS ASSESSMENTS FOR SPACE STATION OFFICE
- o RECOMMEND
 - IN-SPACE RT&E ADVISORY COMMITTEE
 - LEAD - OAST AND OSS
 - o OTHER GOVT.: DOD, DOE, DOT, SDIO
 - o ACADEMIA
 - o INDUSTRY
 - FUNCTIONS
 - o TDM REQUIREMENTS DOCUMENT
 - o DEFINITION OF FACILITIES
 - o DETERMINATION OF SPACE STATION IMPACTS
 - o PLANNING AND CONDUCTING SYMPOSIA
 - o PRIORITIZING AND CATEGORIZING TDMS
 - o RECOMMENDATIONS TO OAST FOR BUDGET AND SCHEDULES
- o YEARLY SYMPOSIUM
 - PUBLISHED VOLUMES

THEME

PRESENTATION

MATERIAL

CONTROLLED THRUST PROPULSION TECHNOLOGY

- OBJECTIVE:** TO PROVIDE A SPACE STATION BASED CAPABILITY FOR TEST AND EVALUATION OF THE PERFORMANCE, LIFETIME, AND INTEGRATION CHARACTERISTICS OF ADVANCED LOW-THRUST PROPULSION SYSTEMS— ELECTRICAL, CHEMICAL AND ADVANCED CONCEPTS.
- JUSTIFICATION:** GROUND FACILITIES ARE NOT CAPABLE OF PROVIDING ACCURATE DATA REQUIRED FOR APPLICATION OF NEW PROPULSION CONCEPTS TO SPACECRAFT, E.G.—
- PARTICULATE EFFLUX IN REAR AND FORWARD HEMISPHERE
 - EMI SPECTRUM, LEVEL, AND PATTERN
- NO TOTALLY SATISFACTORY MEANS OF TESTING AND EVALUATION EXIST WITH GROUND-BASED FACILITIES FOR—
- HIGH TEMPERATURE THRUSTER LIFE AND PERFORMANCE
 - CORRELATION OF SPACE AND GROUND DATA.
- SPACE DEMONSTRATION OF NEW TECHNOLOGY GENERALLY REQUIRED PRIOR TO APPLICATION.



SPACE PROPULSION TECHNOLOGY DIVISION

Lewis Research Center



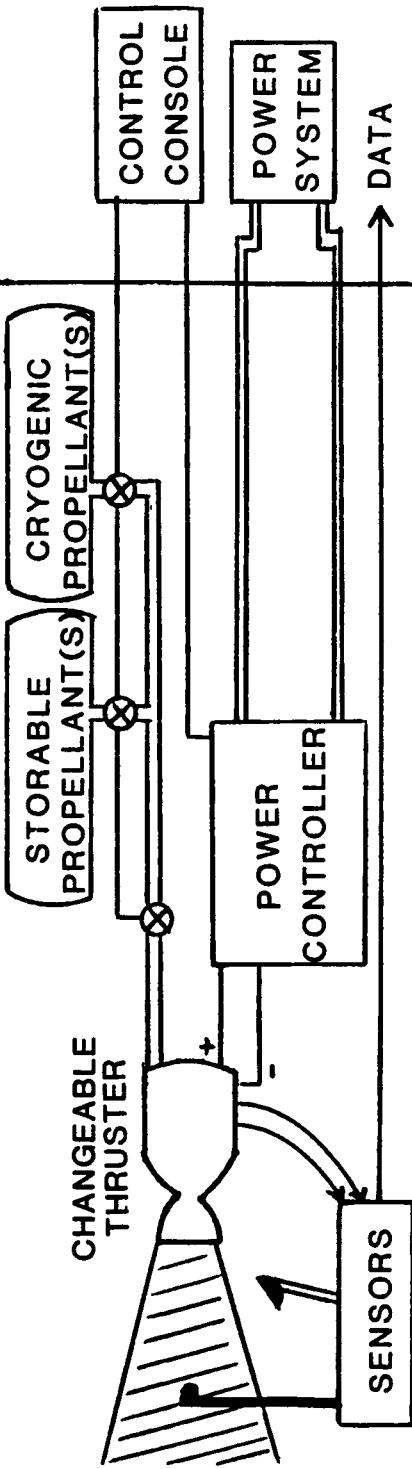
CONTROLLED THRUST PROPULSION TECHNOLOGY

DESCRIPTION: SPACE STATION BASED FACILITY WITH FLEXIBILITY
TO TEST AND CHARACTERIZE ACCURATELY
ADVANCED AUXILIARY PROPULSION SYSTEMS FOR:

- PARTICULATE EFFLUX
- PERFORMANCE
- LIFE
- E.M.I.

LOW THRUST PROPULSION TEST FACILITY

SPACE STATION



EXPERIMENT TITLE: CONTROLLED ACCELERATION PROPULSION TECHNOLOGY

PROPOSED FLIGHT DATE - 1992 YEAR (FACILITY BUILD-UP AND
CHECK-OUT) FOLLOWED BY AN ONGOING SERIES OF SPECIFIC EXPERIMENTS.)

OPERATIONAL DAYS REQUIRED - FOR BUILD-UP AND CHECK-OUT, FOLLOWED BY
AN ONGOING SERIES OF SPECIFIC EXPERIMENTS OF 10 DAYS TYPICAL DURATION.

MASS - 200 KG

VOLUME:

STORED: W 2 M x L 2 M x H 2 M = 8 M³

DEPLOYED: W 2 M x L 6 M x H 2 M = 24 M³ (OPEN TO
SPACE)

INTERNAL ATTACHED (~~YES~~/NO)

EXTERNAL ATTACHED (YES/~~NO~~)

FORMATION FLYING (~~YES~~/NO)

ORIENTATION (inertial, solar, earth, other) VARIABLE (TO PROVIDE RANGE OF PRESSURE)

EXTRA-VEHICULAR ACTIVITY REQUIRED: (PER EXPERIMENT) TYPICAL)

SET-UP: 2 Hrs/Day 1 No. of days

OPERATIONS: 0 Hrs/Day 0 No. of days 0 Interval

SERVICING: 2 Hrs/Day 1 No. of days 5 Interval

INTRA-VEHICULAR ACTIVITY REQUIRED: (PER EXPERIMENT, TYPICAL)

SET-UP: 2 Hrs/Day 1 No. of days

OPERATIONS: 2 Hrs/Day 10 No. of days 1 Interval

SERVICING: 2 Hrs/Day 1 No. of days 5 Interval

POWER REQUIRED:

UP TO 30 KW AC or DC (circle one) (DEPENDENT ON
SPECIFIC EXPERIMENT)
10 Hrs/Day 10 No. of days (TYPICAL)

DATA RATE: ~ 1 Megabits/second

DATA STORAGE: ~ 1 Gigabits

J.R. STONE

Update to presentation by J. R. Stone on

"Controlled Acceleration Propulsion Technology"
(Low Thrust Laboratory)

Clarification of 30-KW power requirement:

For runs of 1-hr duration - 30 KW-hrs would be required, which can be accommodated by lower instantaneous requirement using storage with charging during non-operating time - This would add some mass and volume.

LASER PROPULSION (TDMX 2322)

EXPERIMENT OBJECTIVE - TO TEST THE IN-SPACE OPERATION OF A LASER THRUSTER

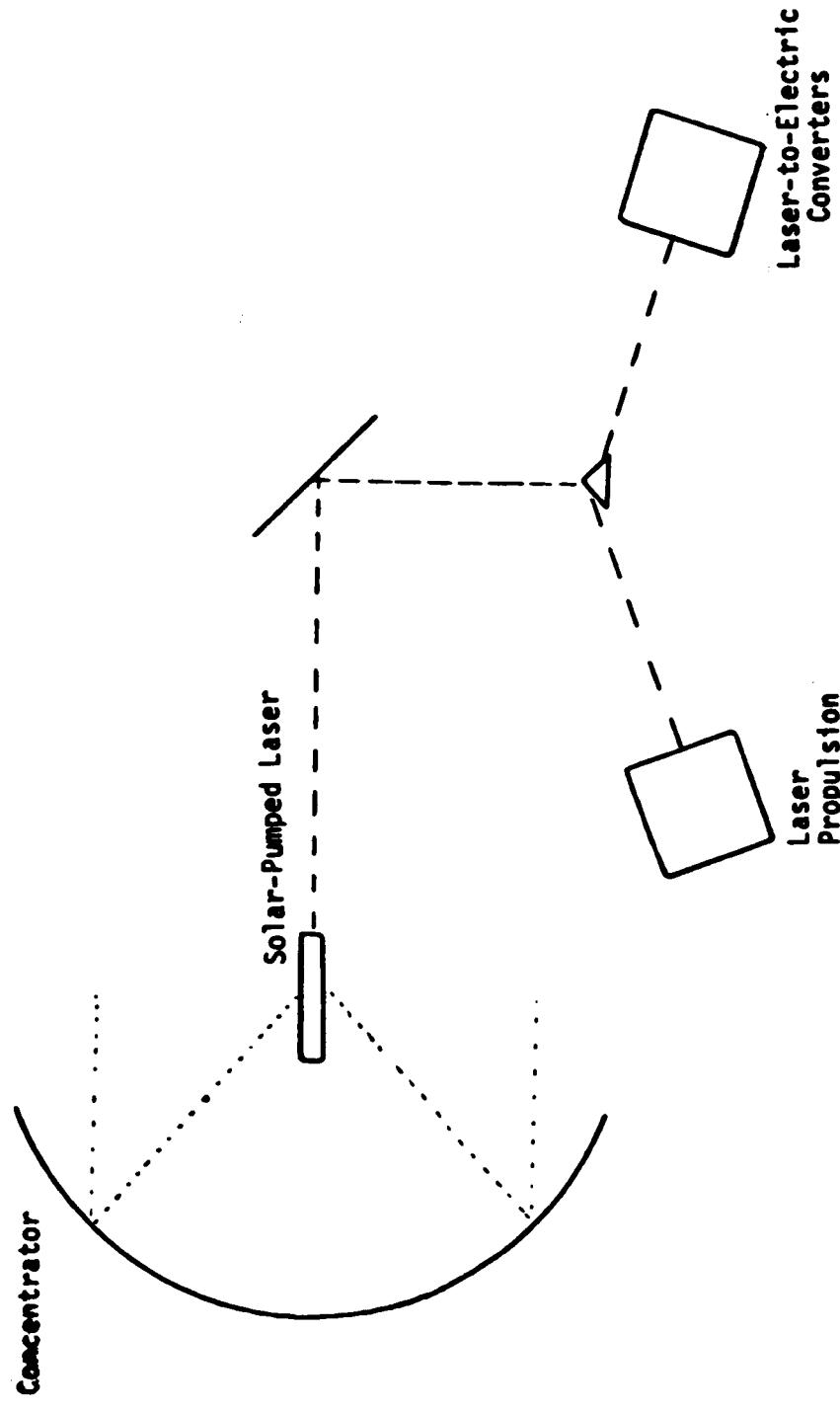
THIS IS THE FOURTH OF FOUR INTERRELATED EXPERIMENTS TO TEST KW-LEVEL SOLAR-PUMPED LASERS AND LASER CONVERTERS FOR POWER AND PROPULSION. IT IS A COMBINED MSFC AND LARC EXPERIMENT IN WHICH MARSHALL SUPPLIES AND TESTS THE THRUSTER AND LANGLEY PROVIDES THE LASER POWER. THE LANGLEY SUPPORT IS DERIVED FROM AN EXISTING SOLAR CONCENTRATOR (TDMX 2111) AND AN OPERATING SOLAR-PUMPED LASER (TDMX 2121) PROVIDING A MAXIMUM POWER OF AT LEAST 1 KW. THE OBJECTIVES OF THE LASER THRUSTER EXPERIMENT ARE (1) TO COMPARE THE MEASURED THRUST TO CALCULATIONS AND LABORATORY EXPERIMENTS (2) TO ASSESS THE TECHNIQUES EMPLOYED FOR THRUST CHAMBER WALL COOLING (PLASMA TEMPERATURE BETWEEN 5,000°K AND 20,000°K) AND THE STABILITY OF THE LASER GENERATED PLASMA, AND (3) TO DEMONSTRATE THE MECHANICAL, THERMAL AND OPTICAL STABILITY OF THE WINDOW BETWEEN THE THRUST CHAMBER AND THE SPACE ENVIRONMENT.

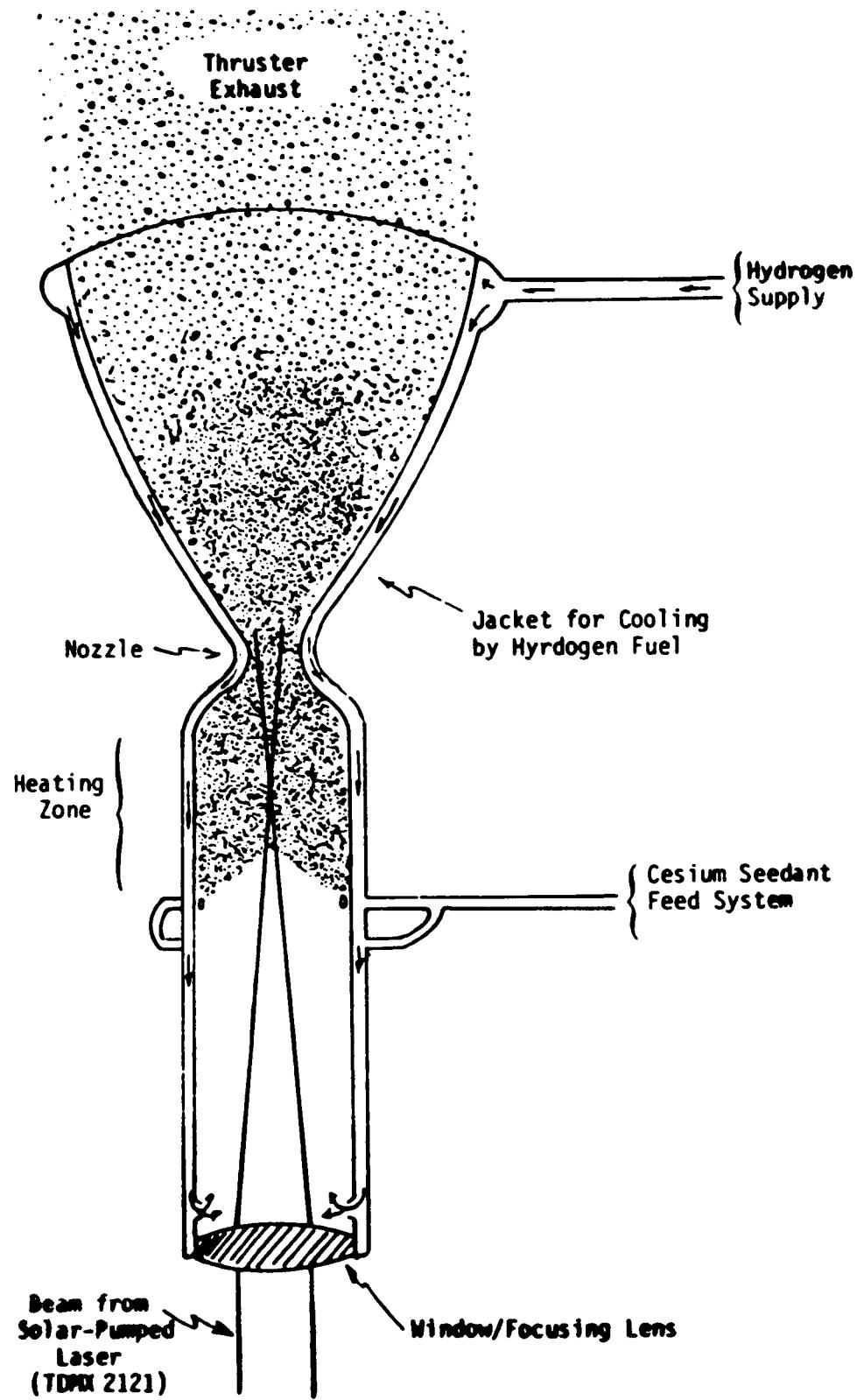
LASER PROPULSION (TDMX 2322)

EXPERIMENT DESCRIPTION

THE PURPOSE OF THIS EXPERIMENT IS TO TEST THE IN-SPACE OPERATION OF A LASER POWERED, CESIUM (OR WATER) SEEDED HYDROGEN THRUSTER. THE MAXIMUM INCIDENT LASER POWER IS BETWEEN ONE AND TWO KILOWATTS. THRUST LEVELS WILL BE LESS THAN 1/10TH OF A POUND. THE THRUSTER WILL BE LOCATED IN THE FAR-FIELD REGION OF THE LASER AND WILL TYPICALLY OPERATE FOR 10 SECOND EXPERIMENTAL PERIODS. WITHIN THE LASER-INDUCED PLASMA ZONE, FLOW INSTABILITY (WHICH INCREASES WALL HEATING) IS INFLUENCED BY CONVECTION AND IS THUS 0-6 SENSITIVE. OPTICAL ABSORPTION, NON-UNIFORM LASER ILLUMINATION, SHOCK LOADING, AMBIENT ATOMIC-OXYGEN EROSION AND BROADBAND THERMAL RADIATION PRODUCES MANY STRESSES IN THE WINDOW. THE MEASURED SYSTEM PARAMETERS WILL BE THRUST, PLASMA-, WALL- AND WINDOW-TEMPERATURES, PLASMA STABILITY, HYDROGEN AND SEEDEDANT FLOW RATES, EXHAUST GAS VELOCITY, AND WINDOW STRAIN.

Four Interrelated TDM Experiments





Basic Thruster Unit Using Cesium Seedant.

EXPERIMENT TITLE: TDMX 2322 Laser Propulsion

PROPOSED FLIGHT DATE - 1992 YEAR

OPERATIONAL DAYS REQUIRED - 30

MASS - 55 KG

VOLUME: 1 m³

STORED W 1 x L 1 x H 1 = 1 M³

DEPLOYED W 1 x L 1 x H 1 = 1 M³

INTERNAL ATTACHED no (YES/NO)

EXTERNAL ATTACHED yes (YES/NO)

FORMATION FLYING no (YES/NO)

ORIENTATION (inertial, solar, earth, other) (Solar - see TDMX 2111)

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 1 Hrs/Day 1 No. of days

OPERATIONS: 1 Hrs/Day 1 No. of days 3 day Interval

SERVICING 1 Hrs/Day 1 No. of days week Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 1 Hrs/Day 1 No. of days

OPERATIONS: 0 Hrs/Day No. of days Interval

SERVICING 0 Hrs/Day No. of days Interval

POWER REQUIRED:

.19 KW AC or DC (circle one)

12 Hrs/Day 30 No. of days

DATA RATE: .01 Megabits/second

DATA STORAGE: 0 Gigabits



SPACE EXPERIMENTS OFFICE

ION AUXILIARY PROPULSION SYSTEM

ION AUXILIARY PROPULSION SYSTEM FLIGHT TEST

EXPERIMENT OBJECTIVES:

- VERIFY IN-SPACE THE TECHNOLOGY AND FUNCTIONAL OPERATION OF A MERCURY ION THRUSTER SYSTEM WHICH IS SUITABLE FOR AUXILIARY ELECTRIC PROPULSION APPLICATIONS
 - THRUST DURATION
 - ON/OFF CYCLES
 - DUAL THRUSTER OPERATIONS
- PROVIDE DESIGN INFORMATION OF THE SYSTEM PERFORMANCE AND SYSTEM INTERFACES WITH SPACECRAFT

SPACE EXPERIMENTS OFFICE



ION AUXILIARY PROPULSION SYSTEM

EXPERIMENT DESCRIPTION: THE IAPS CONSISTS OF TWO MERCURY ION THRUSTER SUBSYSTEMS AND A DIAGNOSTIC SUBSYSTEM.

EACH OF THE MERCURY ION THRUSTER SUBSYSTEMS CONSISTS OF A THRUSTER GIMBAL BEAM SHIELD UNIT (TGBSU), A POWER ELECTRONICS UNIT (PEU), A PROPELLANT TANK VALVE AND FEED UNIT (PTVFU), A DIGITAL CONTROLLER AND INTERFACE UNIT (DCIU), AND THE ASSOCIATED HARNESS. THE TGBSU CONSISTS OF A 5 MILLINEWTON, 8 CM DIAMETER MERCURY ION BOMBARDMENT THRUSTER, A SHIELD TO INTERCEPT ANY EFFLUX FROM THE BEAM IN ONE RADIAL DIRECTION, AND A GIMBAL MECHANISM CAPABLE OF \pm 10 DEGREE DEFLECTION IN TWO ORTHOGONAL DIRECTIONS. THE PEU ACCEPTS POWER FROM A 52 TO 90 VDC BUS AND CONVERTS IT TO THE NINE REGULATED POWER SUPPLY OUTPUTS REQUIRED TO OPERATE THE ION THRUSTER. THE PTVFU CONSISTS OF A BLOW-DOWN TYPE MERCURY STORAGE TANK, A PRESSURE TRANSDUCER, A LATCHING VALVE, AND ASSOCIATED PROPELLANT LINES. THE DCIU CONSISTS OF A MICROPROCESSOR THAT AUTONOMOUSLY EXECUTES THE ALGORITHMS REQUIRED TO START UP, OPERATE, CHANGE THE OPERATING STATE OF, AND PROTECT THE ION THRUSTER. THE DCIU ALSO PROVIDES THE COMMAND AND TELEMETRY INTERFACE WITH THE SPACECRAFT.

THE DIAGNOSTIC SUBSYSTEM DETECTS AND MEASURES THRUSTER EFFLUX, MATERIAL DEPOSITION AND S/C POTENTIAL RELATIVE TO THE LOCAL SPACE PLASMA.

THE IAPS THRUSTERS WILL BE OPERATED TO SIMULATE A 7-YEAR MISSION ON A TYPICAL GEOSTATIONARY COMMUNICATION SATELLITE. THIS REQUIRES COMPLETING 2,500 ON/OFF CYCLES AND ACCUMULATING 7,000 HOURS OF THRUSTING TIME.

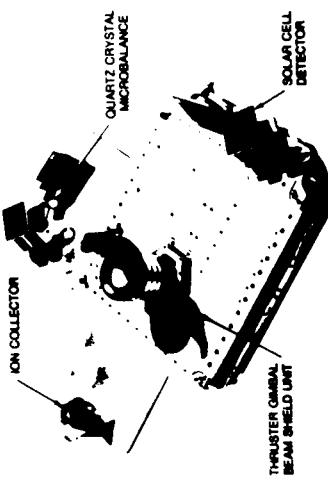
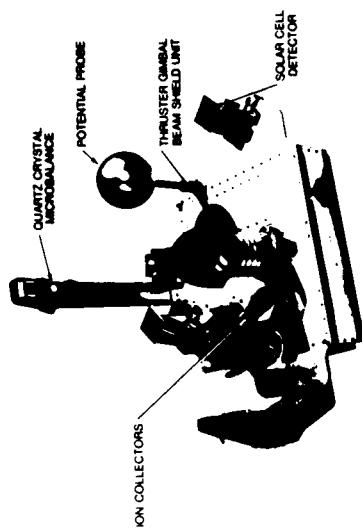
WILLIAM J. BIFANO

SPACE EXPERIMENTS OFFICE



ION AUXILLIARY PROPULSION SYSTEM

- **OBJECTIVE**
PROVIDE FLIGHT EVALUATION OF
ELECTRIC PROPULSION TECHNOLOGY
BASED ON A SEVEN YEAR
SYNCHRONOUS SATELLITE MODEL.
- **HQ PROGRAM OFFICE**
OAST
- **TECHNOLOGY USERS**
 - SPACECRAFT STATION KEEPING
 - ALTITUDE CONTROL OF
COMMUNICATIONS, MILITARY, AND
SCIENTIFIC SATELLITES





SPACE EXPERIMENTS OFFICE

ION AUXILIARY PROPULSION SYSTEM

PROJECT STATUS, OCTOBER 1985:

- IAPS HAS SUCCESSFULLY PASSED ALL QUALIFICATION TESTING ON THE FLIGHT SPACECRAFT
- NO IAPS CHANGES OR REPAIRS REQUIRED (NO FAILURES)
- IAPS FLIGHT ION THRUSTERS REMOVED FROM SPACECRAFT
 - NOMINAL THRUSTER PERFORMANCE VERIFIED IN VACUUM OPERATION
 - EASE OF THRUSTER IGNITION AND ROUTINE OPERATIONAL STABILITY, AFTER 3 YEARS IN AIR, MARKS A SIGNIFICANT MILESTONE IN THE DEVELOPMENT OF ION THRUSTER TECHNOLOGY
- IAPS FLIGHT THRUSTERS REINSTALLED ON THE SPACECRAFT THE WEEK OF SEPTEMBER 9, 1985
- IAPS IS MISSION READY

WILLIAM J. BIFANO

BIOREACTOR TECHNOLOGY IN SPACE

OBJECTIVE:

Bioreactor Tech Dev
DEMONSTRATE TECHNOLOGY FOR IMPROVED YIELDS OF VALUABLE CELL CULTURES IN MICROGRAVITY.

DESCRIPTION:

MANY TYPES OF CELLS SECRETE PROTEINS AND OTHER PRODUCTS OF CONSIDERABLE POTENTIAL MEDICINAL VALUE. IN SOME CASES THE CELLS THEMSELVES ARE OF VALUE. THE BIOREACTOR IS A DEVICE FOR SUPPORTING GROWTH OF THESE LIVE BIOLOGICAL SYSTEMS AND THE EXTRACTION OF THEIR SECRETED PRODUCTS. THE DEVICE PROVIDES THERMAL, IONIC CONCENTRATION, PH, NUTRITIONAL, AND OTHER LIFE SUPPORT FUNCTIONS NECESSARY TO ALLOW CELL GROWTH. EARTH BASED SYSTEMS ARE DIFFICULT TO SCALE UP BECAUSE OF SEDIMENTATION EFFECTS WITHIN THE GROWTH CHAMBER. TYPICALLY A LARGE AMOUNT OF RAW "BROTH" IS REQUIRED FOR FURTHER PROCESSING BY ELECTROPHORETIC METHODS. A SPACE BASED BIOREACTOR COULD SIGNIFICANTLY INCREASE YIELDS WHILE ALSO PROVIDING INPUT TO A SPACE BASED ELECTROPHORESIS DEVICE. THE SYNERGISTIC ENHANCEMENTS OF THESE DEVICES FORMS THE BASIS FOR A MANUFACTURING PROCESS, IN SPACE, WHICH CANNOT BE MATCHED ON EARTH.

EXPERIMENT TITLE: Bioreactor Technology in Space

PROPOSED FLIGHT DATE - 1987 + **YEAR**

OPERATIONAL DAYS REQUIRED - 20

MASS - 140 **KG**

VOLUME:

STORED: W .8 x L 1.3 x H .8 = 0.64 M³

DEPLOYED: W " x L " x H " = " M³

1.0

INTERNAL ATTACHED yes (YES/NO)

EXTERNALLY ATTACHED no (YES/NO)

FORMATION FLYING ? (YES/NO)

ORIENTATION (inertial, solar, earth, other) N/A

EXTRA-VEHICULAR ACTIVITY REQUIRED: N/A

SET-UP: _____ Hrs/Day _____ No. of days

OPERATIONS: _____ Hrs/Day _____ No. of days _____ Interval

SERVICING: _____ Hrs/Day _____ No. of days _____ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 8 Hrs/Day 2 No. of days

OPERATIONS: 6 Hrs/Day 20 No. of days 5 h Interval

SERVICING: 8 Hrs/Day 2 No. of days 7 d₂ Interval

POWER REQUIRED:

1.0 KW AC or DC (circle one)

24 Hrs/Day 20 No. of days

DATA RATE: .004 Megabits/second

DATA STORAGE: 10⁻² Gigabits

Medical Technologies Dev.
SURGERY IN SPACE

OBJECTIVE:

DEVELOP A SURGICAL MODULE AND SURGICAL TECHNIQUES FOR THE MICROGRAVITATIONAL ENVIRONMENT.

DESCRIPTION:

MAJOR AND MINOR SURGICAL PROCEDURES FORM AN IMPORTANT COMPONENT OF COMPLETE HEALTH CARE. THE TECHNOLOGIES TO BE DEVELOPED INCLUDE PATIENT AND PHYSICIAN RESTRAINTS, INSTRUMENT HANDLING, AND BIOLOGICAL WASTE PRODUCT HANDLING. AN AIR FLUID SEPARATOR AND SUCTION DEVICE MUST BE DEVELOPED. INITIALLY, ON SPACE STATION, ACCIDENTS REQUIRING MINOR SURGERY ARE APT TO OCCUR. THESE INCLUDE LACERATIONS, ABSCESS DRAINAGE, AND BLUNT TRAUMAS. LATER MISSIONS SUCH AS MOON BASE, SPACE COLONY, AND MARS MISSION WILL REQUIRE MORE SOPHISTICATED SURGICAL CAPABILITY. INITIAL EXPERIMENTS WOULD BE DONE ON ANIMALS ON THE O-G KC135 THEN ON SHUTTLE OR STATION. THE HEALTH MAINTENANCE FACILITY PLANNED FOR SPACE STATION HAS MINOR SURGICAL CAPABILITIES.

EXPERIMENT TITLE: Surgery in Space

PROPOSED FLIGHT DATE - 1987 + YEAR

OPERATIONAL DAYS REQUIRED - 6

MASS - 70 KG

VOLUME:

STORED: W 1 x L 0.5 x H 2 = 1.0 M³

DEPLOYED: W 1 x L 1.5 x H 2 = 3.0 M³

INTERNAL ATTACHED yes (YES/NO)

EXTERNAL ATTACHED no (YES/NO)

FORMATION FLYING no (YES/NO)

ORIENTATION (inertial, solar, earth, other) N/A

EXTRA-VEHICULAR ACTIVITY REQUIRED: N/A

SET-UP: _____ Hrs/Day _____ No. of days

OPERATIONS: _____ Hrs/Day _____ No. of days _____ Interval

SERVICING: _____ Hrs/Day _____ No. of days _____ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 2 Hrs/Day 6 No. of days

OPERATIONS: 6 Hrs/Day 6 No. of days _____ Interval

SERVICING: 2 Hrs/Day 2 No. of days 3 day Interval
1

POWER REQUIRED:

0.3 KW AC or DC (circle one)

8 Hrs/Day 6 No. of days

DATA RATE: 10⁻⁴ Megabits/second

DATA STORAGE: 10⁻² Gigabits

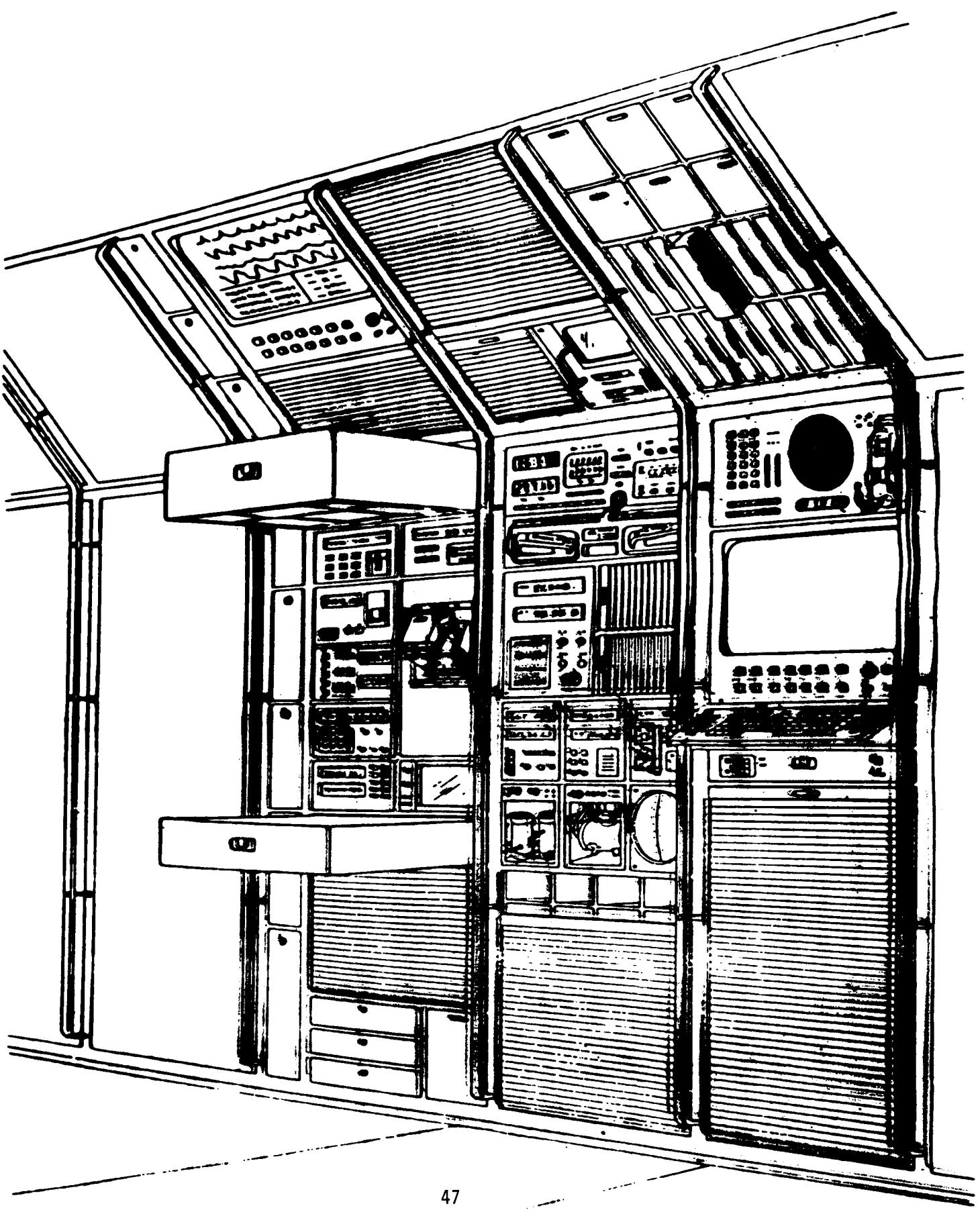
Enabling
MEDICAL EXPERIMENTS, TECHNOLOGY

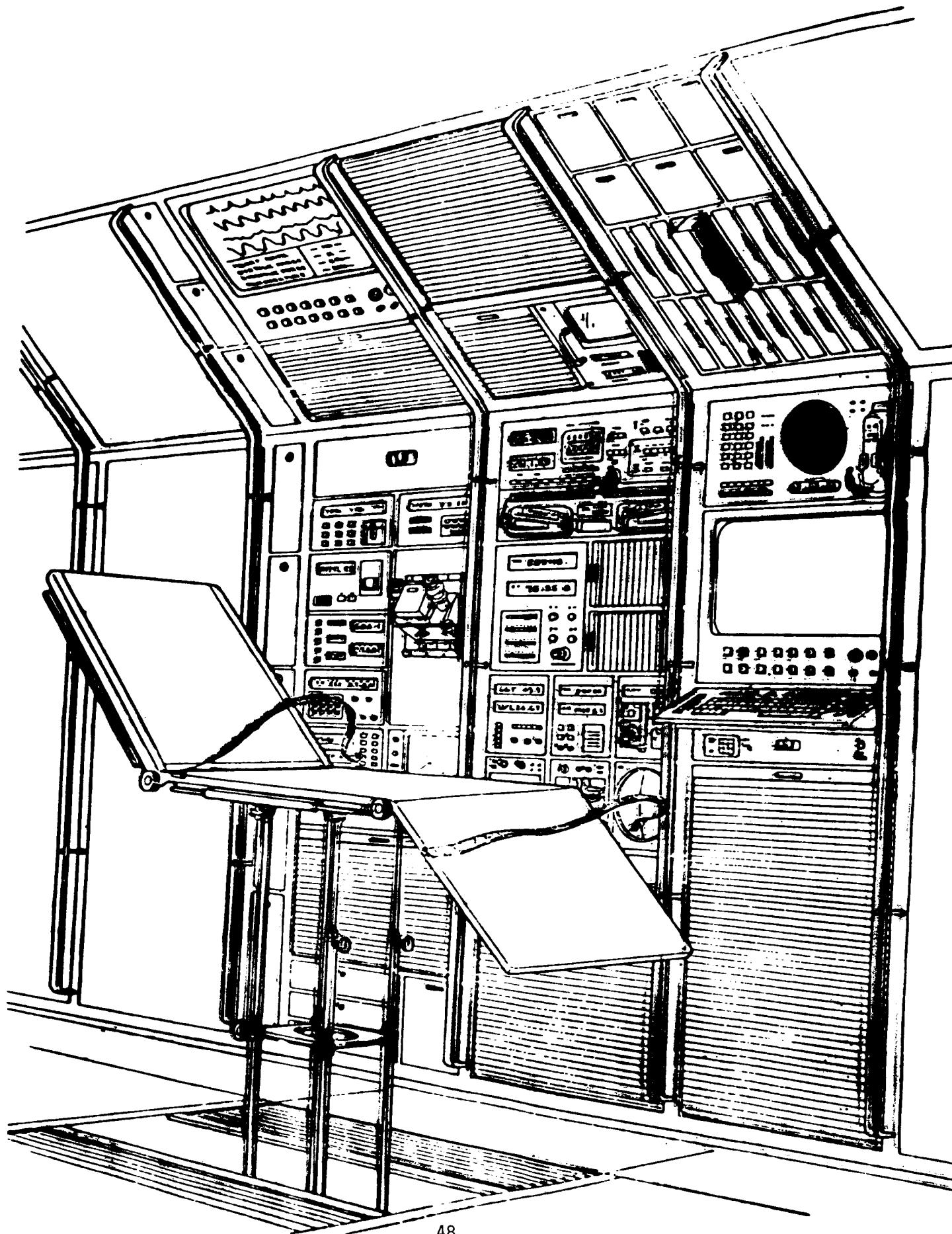
OBJECTIVE:

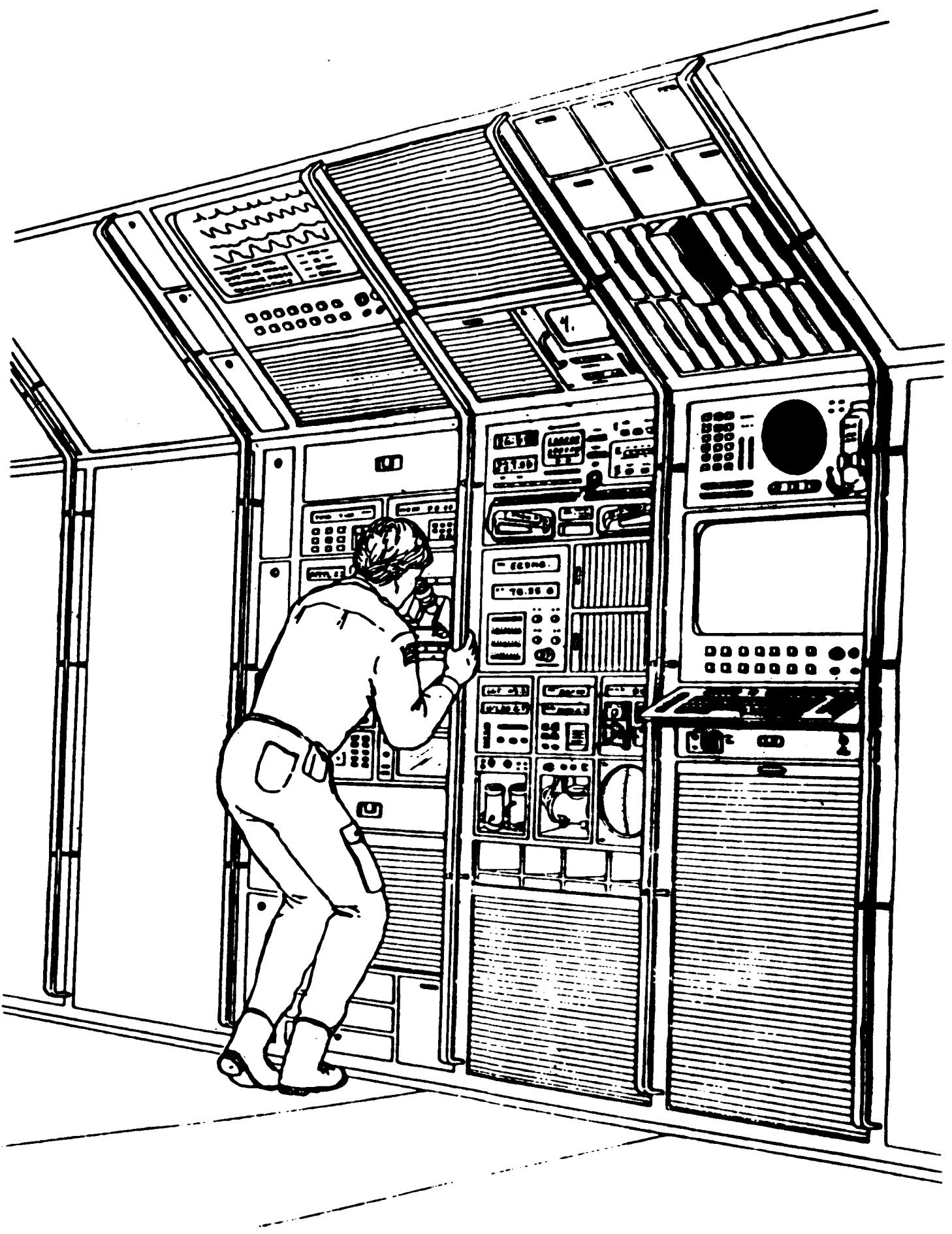
DEVELOP MEDICAL TECHNOLOGIES TO ACCOMPLISH RESEARCH ON COUNTERMEASURES TO THE MICROGRAVITATIONAL ENVIRONMENT. ALLOW MAN TO SAFELY AND EFFICIENTLY LIVE AND WORK IN SPACE AND THEN RETURN TO THEIR BASELINE LEVELS AFTER RETURNING TO EARTH.

DESCRIPTION:

IN ORDER TO ACCOMPLISH RESEARCH ON COUNTERMEASURES TO ILL EFFECTS OF MICROGRAVITY MAN MUST BE EXPOSED TO ADEQUATE PERIODS OF THIS ENVIRONMENT AND THEN MANY OF THE ANALYSES SHOULD BE CARRIED OUT ON ORBIT. THIS REQUIRES THE SKILLS OF HIGHLY TRAINED CREWMEMBERS. AREAS OF INTEREST INCLUDE MEDICAL IMAGING TECHNIQUES SUCH AS COMPUTERIZED AXIAL TOMOGRAPHY, NUCLEAR MAGNETIC RESONANCE, AND ULTRASONIC STUDIES. OTHER STUDIES REQUIRE SPECIMEN ANALYSIS WITH MASS SPECTROSCOPY, ELECTRON MICROSCOPES, AND OTHER HIGHLY SPECIALIZED EQUIPMENT. ANIMAL EXPERIMENTATION WILL BE ACCOMPLISHED AS IS APPLICABLE. THIS REQUIRES DEVELOPMENT OF ADEQUATE ANIMAL HANDLING TECHNIQUE. A DEDICATED FACILITY TO PROVIDE STANDARD SERVICES AND INTERFACES FOR INTERCHANGEABLE RESEARCH EQUIPMENT IS AN EFFECTIVE APPROACH TO THESE LONG TERM STUDIES THAT WILL ULTIMATELY ALLOW MAN TO LIVE AND WORK IN SPACE WITHOUT SUFFERING LONG TERM OR SEVERE DETRIMENTAL EFFECTS.







EXPERIMENT TITLE: Medical Experiments Technology

PROPOSED FLIGHT DATE - 1987 + **YEAR**

OPERATIONAL DAYS REQUIRED - 7 /experiment

MASS - 800 KG

VOLUME:

STORED: W 2 x L 1 x H 2 = 4 M³

DEPLOYED: W 2 x L 2.2 x H 2 = 8.8 M³

INTERNAL ATTACHED yes (YES/NO)

EXTERNALLY ATTACHED no (YES/NO)

FORMATION FLYING no (YES/NO)

ORIENTATION (inertial, solar, earth, other) N/A

EXTRA-VEHICULAR ACTIVITY REQUIRED: N/A

SET-UP: _____ Hrs/Day _____ No. of days

OPERATIONS: _____ Hrs/Day _____ No. of days _____ Interval

SERVICING: _____ Hrs/Day _____ No. of days _____ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 8 Hrs/Day 3 No. of days

OPERATIONS: 8 Hrs/Day 7 No. of days _____ Interval

SERVICING: 8 Hrs/Day 1 No. of days week Interval

POWER REQUIRED:

4 KW AC or DC (circle one)

1 Hrs/Day 7 No. of days

DATA RATE: 2.0 Megabits/second

DATA STORAGE: 0.1 Gigabits



SPACE EXPERIMENTS OFFICE

SPACECRAFT FIRE SAFETY TECHNOLOGY

JACK SALZMAN

EXPERIMENT OBJECTIVE

DEVELOP A DETAILED UNDERSTANDING OF THE CONTROLLING AND CONTRIBUTING MECHANISMS OF FLAMES SPREADING IN A LOW-GRAVITY ENVIRONMENT FOR A VARIETY OF MATERIALS; AND DEVELOP CORRELATION WITH SIMILAR DATA OBTAINABLE IN GROUND-BASED LABORATORIES. THIS UNDERSTANDING WILL BE APPLIED TO THE DEVELOPMENT OF:

- o SPACECRAFT MATERIAL USE CATEGORIES BASED ON LOW-GRAVITY FLAME SPREAD MECHANISMS.
- o INNOVATIVE TECHNIQUES FOR THE EARLY DETECTION OF INCIPIENT FIRES.
- o NEW TECHNIQUES AND MATERIALS FOR USE IN EXTINGUISHING OR INHIBITING FIRES IN LOW-GRAVITY.



SPACE EXPERIMENTS OFFICE

SPACECRAFT FIRE SAFETY TECHNOLOGY

JACK SALZMAN

EXPERIMENT RATIONALE

- o MATERIAL FLAMMABILITY TESTS - EVIDENCE IS AVAILABLE SHOWING SUFFICIENT DIFFERENCES EXIST BETWEEN ONE-G AND LOW-G COMBUSTION PROCESSES TO DICTATE CONTROLLED TESTING/ SCREENING OF EXISTING AND NEW SPACECRAFT MATERIALS EXPECTED TO BE USED ABOARD FUTURE SPACE MISSIONS. TESTS REQUIRE LONG DURATION PERIODS OF μ -G CONDITIONS.
 - o FIRE DETECTION EXPERIMENTS - EXTENSIVE UTILIZATION OF HABITABLE BUT UNOCCUPIED SPACES ABOARD FUTURE SPACE STRUCTURES REQUIRES NEW μ -G FIRE DETECTION TECHNOLOGIES AND TECHNIQUES TO ENABLE A RAPID RESPONSE TO INCIPIENT FIRES.
 - o FIRE EXTINGUISHMENT EXPERIMENTS - RAPID AND AUTOMATIC RESPONSE TO INCIPENT FIRES WITHOUT THE INTRODUCTION OF NEW HAZARDS REQUIRES FIRE EXTINGUISHMENT OPTIONS WHICH ARE COMPATIBLE WITH BOTH μ -G ENVIRONMENTS AND OTHER ENVIRONMENT CONTROL/LIFE SUPPORT SYSTEMS.
- RESULTS OF INITIAL SMALL-SCALE TESTS MAY PROMPT NEED FOR FULL-SCALE REMOTE, FREE-FLYING EXPERIMENTS TO SIMULATE THE ACTIVATION OF A FIRE CONTROL SYSTEM IN RESPONSE TO AN ON-GOING FIRE.



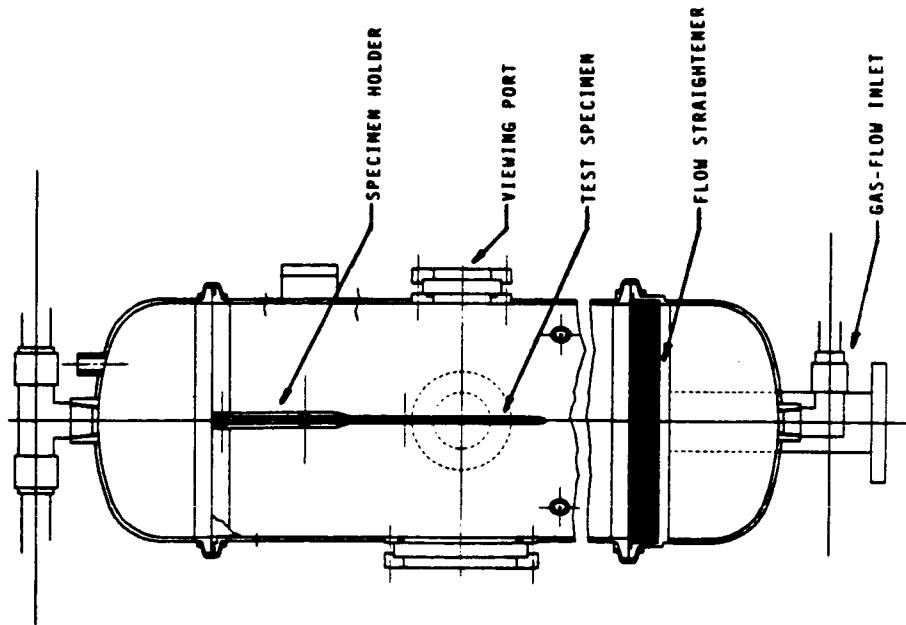
SPACE EXPERIMENTS OFFICE

SPACECRAFT FIRE SAFETY TECHNOLOGY

JACK SALZMAN

EXPERIMENT DESCRIPTION

THE APPARATUS WILL PROVIDE THE ABILITY TO IGNITE AND BURN PREPARED SAMPLES OF MATERIALS IN THE PRESENCE OF A LOW-SPEED FORCED GAS FLOW. THE MEAN VELOCITY, VELOCITY PROFILE AND COMPOSITION (OXYGEN, INERT GAS, EXTINGUISHING AGENT) WILL BE CONTROLLABLE. CONVENTIONAL INSTRUMENTATION INCLUDING MODERATE SPEED VIDEO, PRESSURE AND TEMPERATURE MEASUREMENTS WILL BE REQUIRED. FLOW FIELD CHARACTERIZATION WILL REQUIRE MODERATE POWER LASER DEVICES. THE SYSTEM WILL BE CONFIGURABLE TO EVALUATE FIRE DETECTION AND EXTINGUISHMENT CONCEPTS.



National Aeronautics and
Space Administration
Lewis Research Center

SPACE EXPERIMENTS OFFICE



SPACECRAFT FIRE SAFETY TECHNOLOGY

JACK SALZMAN

ACCOMMODATION REQUIREMENTS

EXPERIMENT TITLE: Spacecraft Fire Safety Technology

PROPOSED FLIGHT DATE - 1992 YEAR

OPERATIONAL DAYS REQUIRED - 30

MASS - 200 KG

VOLUME:

STORED: W 1.0 x L 1.0 x H 2.0 = 2.0 cu ft
DEPLOYED: W 1.0 x L 1.5 x H 2.0 = 3.0 cu ft

INTERNAL ATTACHED Yes (YES, NO)

EXTERNALLY ATTACHED No (YES, NO)

FORMATION FLYING No (YES, NO)

ORIENTATION (inertial, solar, earth, other) N/A

EXTRA-VEHICULAR ACTIVITY REQUIRED: None

SET-UP: _____ Hrs/Day _____ No. of days

OPERATIONS: _____ Hrs/Day _____ No. of days _____ Interval

SERVICING: _____ Hrs/Day _____ No. of days _____ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED

SET-UP: 2.0 Hrs Day 30 No. of days

OPERATIONS 5.0 Hrs Day 30 No. of days 0 Interval

SERVICING: 8.0 Hrs Day 1 No. of days 2 da. Interval

POWER REQUIRED

2.0 KW AC or DC (circle one)

5.0 Hrs Day 30 No. of days

DATA RATE 0.5 Megabits second

DATA STORAGE 0.3 Gigabit

TETHERED CONSTELLATIONS

EXPERIMENT OBJECTIVE

THE OBJECTIVE IS TO TETHER A PLATFORM 10KM ABOVE SPACE STATION WITH AN IR TELESCOPE ON THE PLATFORM. THE IR TELESCOPE WILL OBSERVE STELLAR AND PLANETARY OBJECTS.

EXPERIMENT DESCRIPTION

THE PLATFORM WILL BE TETHERED 10KM ABOVE THE SPACE STATION IN A 275KM CIRCULAR ORBIT. THE PLATFORM WILL BE GRAVITY GRADIENT STABILIZED. THE PLATFORM POWER WILL BE SUPPLIED BY THE SPACE STATION. THE DEPLOYMENT AND RETRIEVAL OF THE PLATFORM WILL REQUIRE SPACE STATION RESOURCES. AN IR TELESCOPE IS A TYPICAL CASE ONLY.

ONORBIT WELDING

W. T. RANDOLPH
PRINCIPAL INVESTIGATOR
MARTIN MARIETTA MICHoud AEROSPACE
(TO BE PRESENTED BY DR. R. D. JOHNSON)

EXPERIMENT OBJECTIVE

THE LONG RANGE OBJECTIVE IS TO DEVELOP AND DEMONSTRATE WELDING AND CUTTING SYSTEMS CAPABLE OF JOINING AND PARTING AEROSPACE ALLOYS ONORBIT.

MEETING THE OVERALL OBJECTIVE WILL REQUIRE EXTENSIVE GROUND-BASED DEVELOPMENT, TESTING AND SIMULATION TO MEET THE FOLLOWING INTERIM OBJECTIVES:

- (1) PROCESS SELECTION FOR WELDING AND EVALUATION OF THE PRIMARY CONCERNs AND INITIAL DEVELOPMENT IN 1985.
- (2) PROCESS SELECTION FOR CUTTING, CONCEPTUAL AND DETAIL DESIGN OF ONORBIT EXPERIMENT AND COMPLETION OF GROUND-BASED TESTS, INCLUDING SIMULATION MODELING IN 1986.
- (3) SPECIALIZED EQUIPMENT DEVELOPMENT AND PROCUREMENT IN 1987.
- (4) MANIFEST EXPERIMENT FOR ONORBIT FLIGHT DEMONSTRATION IN 1988.

THE PRIMARY NEED IS FOR REPAIR AND THE SECONDARY NEED IS FOR FABRICATION AND ASSEMBLY OPERATIONS IN SPACE.

ONORBIT WELDING/W. T. RANDOLPH, R. D. JOHNSON

EXPERIMENT DESIGN
(APPROACH TO EXPERIMENT DESIGN)

o PROCESS SELECTION

ELECTRON BEAM WELDING PROCESS WAS SELECTED FOR WELDING BASED UPON UTILIZATION OF HIGH VACUUM AND THE MORE ADVANCED STAGE OF EQUIPMENT, INCLUDING THE DEVELOPED FOR DEMONSTRATIONS IN SPACE.

A SIMILAR ANALYSIS AND SELECTION WILL BE PERFORMED FOR THE CUTTING PROCESS.

o INITIAL DEVELOPMENT AND EVALUATION OF PRIMARY CONCERNs

TWO EQUIPMENT MANUFACTURERS WERE SELECTED TO CONDUCT EXPERIMENTAL PROGRAMS TO ESTABLISH WELD PARAMETERS ON LAP JOINTS FOR ALUMINUM ALLOYS 1/16", 1/8", AND 3/16", TO DEVELOP REPAIR WELD TECHNIQUES, TO ASSESS BEAM STABILITY AND CONTROL, AND THE POSSIBLE EFFECTS OF CHARGE BUILD UP, AND TO EVALUATE THE MAGNITUDE OF VAPOR DEPOSITION FROM THE E.B. WELDING PROCESS.

o CONCEPTUAL AND DETAIL DESIGN OF ONORBIT EXPERIMENT

FACTORS TO BE EVALUATED INCLUDE:

OPERATOR AND HARDWARE SAFETY

DEGREE OF MANUAL OPERATION VERSUS AUTOMATION

DEXTERITY REQUIREMENTS FOR EXPERIMENTS

DEBRIS MANAGEMENT AND CONTAMINATION CONTROL

PROCESS CONTROL AND INSPECTION REQUIREMENTS

EQUIPMENT LOCATION REQUIREMENTS

EXPERIMENT LOCATION REQUIREMENTS

INSULATION AND THERMAL ISOLATION/INSULATION REQUIREMENTS

EQUIPMENT DESIGN AND POWER REQUIREMENTS

ONORBIT WELDING/W. T. RANDOLPH, R. D. JOHNSON

EXPERIMENT DESIGN CONTINUED
(APPROACH TO EXPERIMENT DESIGN)

o VERIFICATION OF EXPERIMENT DESIGN TO BE BASED UPON:

PROCESS DEVELOPMENT RESULTS

GROUND-BASED TESTS

SIMULATION MODELING OF THE EXPERIMENT

o SPECIFICATION FOR FLIGHT DEMONSTRATION EQUIPMENT

PREPARED FOR EQUIPMENT MANUFACTURER TO MEET REQUIREMENTS OF
MAXIMUM EFFICIENCY, COMPACTNESS AND RELIABILITY TO MEET THE SPACE AND
POWER AVAILABLE FOR DEMONSTRATION ON THE ORBITER AND SUBSEQUENT USE
ON THE SPACE STATION.

THE MAJOR HARDWARE ELEMENTS ARE THE POWER SUPPLY, THE CONTROLS,
THE TORCH, AND ANY FIXTURING/TOOLING/SUPPORTING MECHANIZATION EQUIPMENT
TO BE DESIGNED SPECIFICALLY FOR PERFORMANCE AND INTERFACING FOR THE
FLIGHT DEMONSTRATION EXPERIMENTS.

W. T. RANDOLPH, R. D. JOHNSON

EXPERIMENT TITLE: ONORBIT WELDING

PROPOSED FLIGHT DATE - 1988 YEAR,
OPERATIONAL DAYS REQUIRED -
MASS - KG

EXPERIMENT SCHEDULE
CONCEPTUAL DESIGN, 6/86
DETAIL DESIGN, 9/86
GROUND-BASED TEST. 12/86

VOLUME:

STORED: W x L x H = M³
DEPLOYED: W x L x H = M³

INTERNAL ATTACHED (YES/NO)
EXTERNAL ATTACHED (YES/NO)
FORMATION FLYING (YES/NO)

ORIENTATION (inertial, solar, earth, other)

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: Hrs/Day No. of days
OPERATIONS: Hrs/Day No. of days Interval
SERVICING: Hrs/Day No. of days Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: Hrs/Day No. of days
OPERATIONS: Hrs/Day No. of days Interval
SERVICING: Hrs/Day No. of days Interval

POWER REQUIRED:

 6 KW AC or DC (circle one), SIZED FOR 3/16" AL
 Hrs/Day No. of days LAP JOINT

DATA RATE: Megabits/second

DATA STORAGE: Gigabits

TETHERED TRANSPORTATION

EXPERIMENT OBJECTIVE

TO SAVE OMV AND OTV PROPELLANT DURING RENDEZVOUS AT THE STATION BY HAVING THE OMV TETHERED TO THE SPACE STATION WHEN THE RENDEZVOUS OCCURS.

EXPERIMENT DESCRIPTION

THE OMV WILL BE DEPLOYED ON A TETHER 13KM BELOW THE SPACE STATION WHERE IT WILL RENDEZVOUS AND DOCK WITH AN OTV. AFTER DOCKING, THE OMV AND OTV WILL BE RETRIEVED BY A TETHER BACK TO THE SPACE STATION.

EXPERIMENT TITLE: TDM 2543 TETHER TRANSPORTATION

PROPOSED FLIGHT DATE - 1997 **YEAR**

OPERATIONAL DAYS REQUIRED - 4

MASS - 11364 **KG**

VOLUME:

STORED: W 2.5 x L 3 x H _____ = 14.7 **M³**

DEPLOYED: W 2.5 x L 3 x H _____ = 14.7 **M³**

INTERNAL ATTACHED NO (YES/NO)

EXTERNALLY ATTACHED YES (YES/NO)

FORMATION FLYING YES (YES/NO)

ORIENTATION (inertial, solar, earth, other) _____

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 12 **Hrs/Day** 2 **No. of days**

OPERATIONS: 1 **Hrs/Day** 90 **No. of days** 90 **Interval**

SERVICING: 2 **Hrs/Day** 1 **No. of days** 360 **Interval**

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: _____ **Hrs/Day** _____ **No. of days**

OPERATIONS: _____ **Hrs/Day** _____ **No. of days** _____ **Interval**

SERVICING: _____ **Hrs/Day** _____ **No. of days** _____ **Interval**

POWER REQUIRED:

_____ 1 **KW** **AC or DC** (circle one)

_____ 12 **Hrs/Day** 4 **No. of days**

DATA RATE: 1 Kbps Megabits/second

DATA STORAGE: 0 Gigabits

SHUTTLE DEORBIT/OTV BOOST FROM SPACE STATION

USING A TETHER

Experiment Objective: The objectives are to aid the deorbit of Shuttles and the boosting of OTVs from the Space Station using a tether system that is a permanent part of the Space Station. The advantage of doing this is to save some of the Shuttle and OTV propellants normally required for these operations.

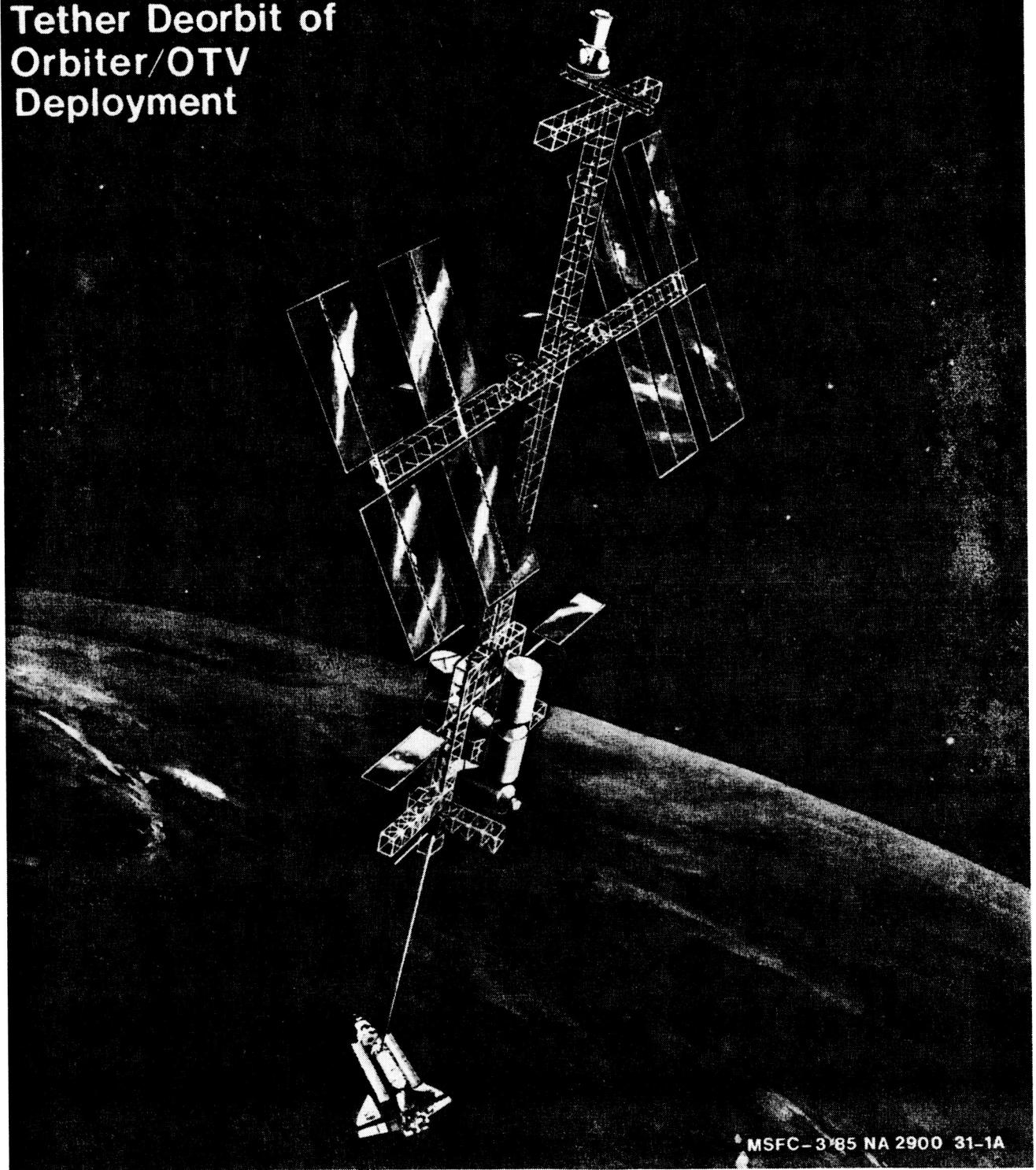
SHUTTLE DEORBIT/OTV BOOST FROM SPACE STATION USING A TETHER

Experiment Description: A tether system, similar in concept to the one now being developed for the Shuttle, will be built on-orbit and incorporated into the Space Station structure. It will weigh approximately 13,000 kg--about one-half of this weight is for a 150 km long tether that is 10 mm in diameter. This tether will be used to lower or deboost Shuttles from the Space Station that are returning to Earth and by so doing save Shuttle OMS propellants that are normally required for such operations. About 3,000 kg of propellant or 65% of normal requirements are saved using a 65 km long tether. This Shuttle deboost will raise the Space Station altitude by about 74 km. To lower it and to save OTV propellants, the same tether--this time using the full 150 km length--will be used at some later time to boost an OTV from the Space Station to geostationary orbit, thereby, saving 2,000 kg of OTV propellants or about 8% of normal requirements for this operation.

These increases in the Space Station altitude that result from Shuttle deboost can be used to overcome altitude losses due to atmospheric drag by the Space Station. An estimated 2500 kg of station-keeping propellant annually, averaged over a 10-year period, can be saved.

If these numbers are multiplied by the annual Shuttle and OTV activity at the station as predicted by some NASA mission models, the average annual propellant savings during the decade of the 1990s are 26,000 kg.

Tether Deorbit of Orbiter/OTV Deployment



MSFC-3'85 NA 2900 31-1A

SHUTTLE DEORBIT/OTV BOOST FROM SPACE STATION
EXPERIMENT TITLE: USING A TETHER

PROPOSED FLIGHT DATE - 1997 YEAR

OPERATIONAL DAYS REQUIRED - 2

MASS - 13,000 KG

VOLUME:

STORED: W 2.5 DIA. x L 3 x H _____ = 14.7 M³

DEPLOYED: W 2.5 DIA. x L 3 x H _____ = 14.7 M³

INTERNAL ATTACHED NO (YES/NO)

EXTERNAL ATTACHED YES (YES/NO)

FORMATION FLYING NO (YES/NO)

ORIENTATION (inertial, solar, earth, other) EARTH

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: _____ Hrs/Day _____ No. of days

OPERATIONS: 8 Hrs/Day 2 No. of days DAY Interval

SERVICING: _____ Hrs/Day _____ No. of days _____ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: _____ Hrs/Day _____ No. of days

OPERATIONS: _____ Hrs/Day _____ No. of days _____ Interval

SERVICING: _____ Hrs/Day _____ No. of days _____ Interval

POWER REQUIRED:

50 KW AC or DC (circle one)

12 Hrs/Day 1 No. of days

DATA RATE: 12 Megabits/second

DATA STORAGE: 0 Gigabits

OTV/PAYLOAD INTERFACING AND TRANSFER
TDMX 2571

JOHN MALONEY

OBJECTIVE: TO ASSESS AND PROOF THE INTERFACES, OPERATIONAL PLANNING/METHODS, AND EQUIPMENT USED FOR OTV PAYLOAD INTEGRATION AND TRANSFER OPERATIONS.

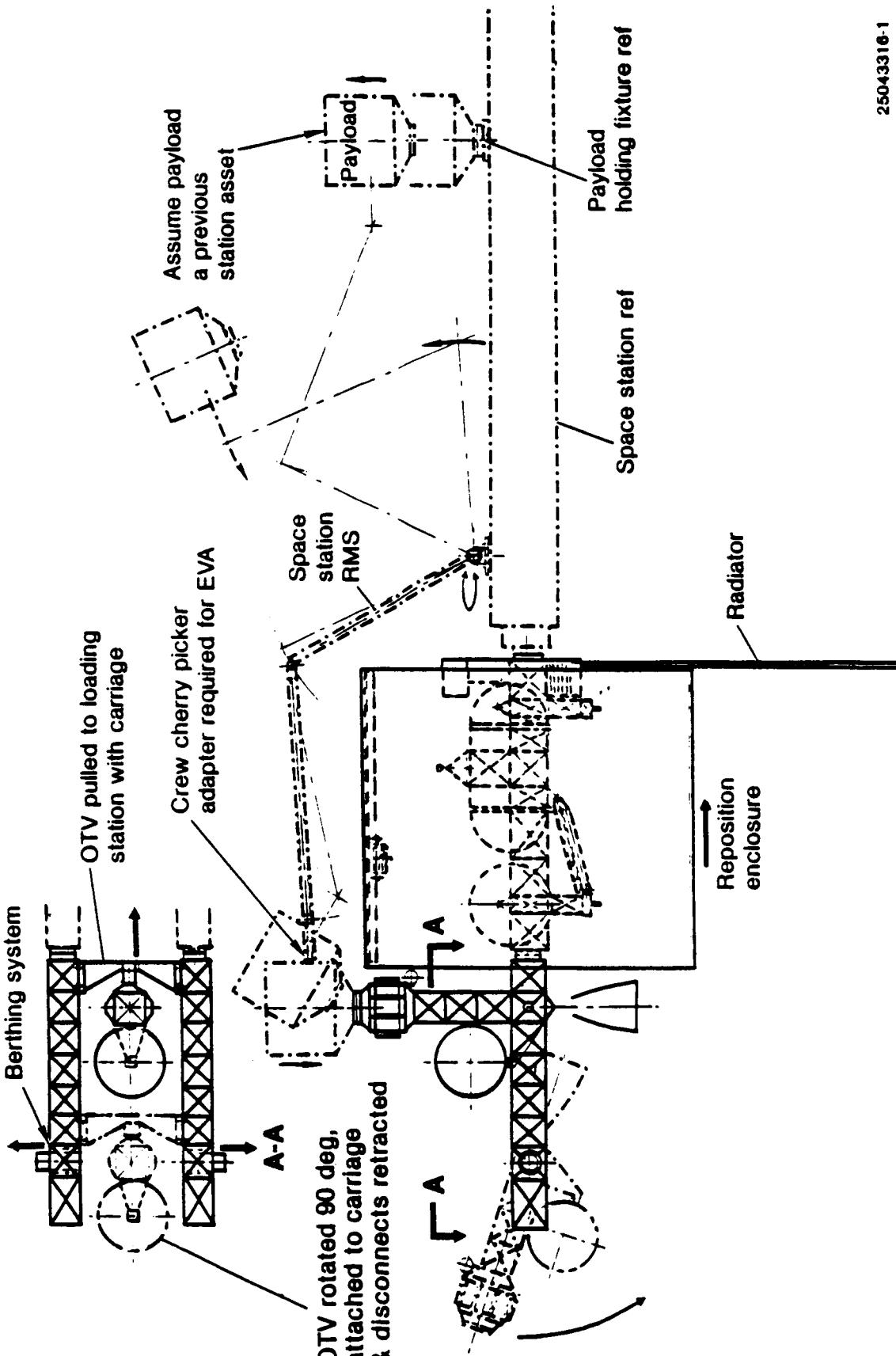
DESCRIPTION: PERFORM OTV/PAYLOAD INTEGRATION OPERATIONS

- USE EXISTING EQUIPMENT AND PAYLOAD
- PERFORM BASIC FUNCTIONS
 - TRANSFER PAYLOAD TO OTV
 - MATE PAYLOAD ON OTV
- PERFORM MAINTENANCE ON PAYLOAD (EVA)
- DEMATE PAYLOAD FROM OTV
- TRANSFER PAYLOAD TO HOLDING FIXTURE

OTV/PAYLOAD INTEGRATION OPERATIONS TDM

JOHN MALONEY

TDMX 2571



JOHN MALONEY

EXPERIMENT TITLE: OTV/PAYLOAD INTERFACING & TRANSFER TDMX2571

PROPOSED FLIGHT DATE - OCTOBER 1993 YEAR

OPERATIONAL DAYS REQUIRED - 6

MASS - 21,439 4500 KG + TDMX 2573

VOLUME:

STORED: W x L x H = M³

DEPLOYED: W 13 x L 19.4 x H 13 = 3279 M³

INTERNAL ATTACHED NO (YES/NO)

EXTERNALLY ATTACHED YES (YES/NO)

FORMATION FLYING NO (YES/NO)

ORIENTATION (inertial, solar, earth, other) NOT CRITICAL

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: Hrs/Day No. of days

OPERATIONS: Hrs/Day No. of days Interval

SERVICING: 4 Hrs/Day 6 No. of days 30 Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: Hrs/Day No. of days

OPERATIONS: 8 Hrs/Day 6 No. of days 30 Interval

SERVICING: Hrs/Day No. of days Interval

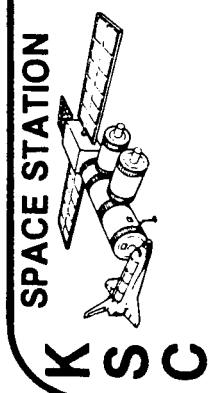
POWER REQUIRED:

0.4 KW AC or DC (circle one)

8 Hrs/Day 6 No. of days

DATA RATE: 1.3 Megabits/second

DATA STORAGE: 2.4 Gigabits

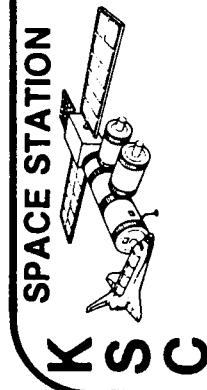


SPACE STATION
SYSTEMS OPERATIONAL
MAINTENANCE TECHNOLOGIES MISSION

J. LEET
OCT. '85

O OBJECTIVE

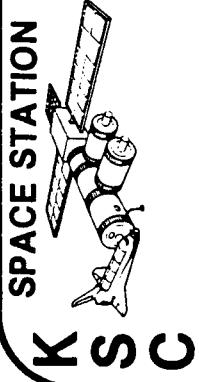
- O DEVELOP/EXPAND THE TECHNOLOGY REGIME FOR SPACE BASED ON-BOARD MAINTENANCE TECHNIQUES/TECHNOLOGY
- O DEVELOP THE FEASIBILITY OF A SYSTEMS OPERATIONAL TDM WHICH WOULD BE USED TO DEVELOP, EVALUATE, AND VERIFY OPERATIONAL MAINTENANCE CONCEPTS AND RESOURCE REQUIREMENTS
- O IDENTIFY CANDIDATE SYSTEMS AND APPLICATIONS WHICH WOULD BENEFIT FROM A CONTINUING ON-BOARD SPACE STATION MAINTENANCE EXPERIMENT/TEST BED
- O ESTABLISH A MISSION PROFILE TO BE USED IN THE DEVELOPMENT OF A WIDE RANGE OF OPERATIONAL MAINTENANCE PROCEDURES AND TECHNIQUES
- O REALIZE PAYOFF OF INCREASED ASSURANCE OF DEPENDABLE OPERATION, AVAILABILITY, AND LONG LIFE OF SPACE STATION SYSTEMS



SPACE STATION	SPACE STATION SYSTEMS OPERATIONAL MAINTENANCE TECHNOLOGIES MISSION	J. LEET	OCT. '85
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0 DESCRIPTION

- 0 A CONTINUING EXPERIMENT TO INVESTIGATE AND ASSESS THE EFFECTIVENESS OF A WIDE-RANGE OF MAINTENANCE PROCEDURES AND TECHNIQUES TO ASSURE OPTIMAL SPACE-BASED MAN-MACHINE INTERFACES AND SUPPORTABILITY
- 0 DEVELOP THE TECHNIQUES/PROCEDURES TO CREATE, IMPLEMENT, AND MAINTAIN ON A REAL-TIME BASIS THE CAPABILITY FOR : MINOR REPAIR, MODIFICATION, AND SERVICING OF : THE SPACE STATION, EXPERIMENT SUBSYSTEMS, ASSEMBLIES, AND COMPONENTS
- 0 PROVIDES THE CONTINUOUSLY MANNED PLATFORM TO PERFORM INVESTIGATIONS OVER A PERIOD OF TIME
- 0 PROVIDES THE CAPABILITY FOR ON-BOARD CREW TRAINING OR SPECIALIZED INSTRUCTION TO ACCOMMODATE ON-ORBIT REPAIR OR TECHNOLOGY UPDATES



SPACE STATION
SYSTEMS OPERATIONAL
MAINTENANCE TECHNOLOGIES MISSION

J. LEET

OCT. '85

0 SYSTEMS OPERATIONS MAINTENANCE TECHNOLOGIES

0 SUPPORTING STUDIES

- 0 EXPERT SYSTEMS
- 0 LOX LOADING
- 0 PLANS AND SCHEDULES
- 0 LOGISTICS

0 MAINTENANCE TECHNOLOGIES

- 0 AUTOMATION
- 0 FAULT DETECTION
- 0 FAULT ISOLATION
- 0 BITE

0 ON-ORBIT OPERATIONS

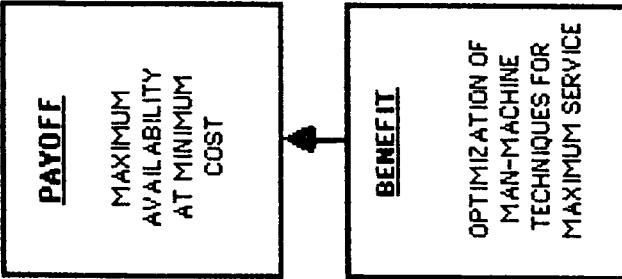
- 0 STATION OPERATIONS
- 0 EVA/IVA OPERATIONS
- 0 MAINTENANCE/REPAIR TECHNIQUES

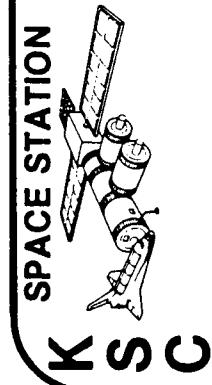
0 SUPPORTABILITY

- 0 SPARES/REPAIR
- 0 MAINTAINABILITY
- 0 CREW
- 0 CUSTOMER

0 SUPPORTING STUDIES

- 0 ADVANCED DATA COLLECTION
- 0 CAD/CAM





SPACE STATION	SPACE STATION	J. LEET
K	SYSTEMS OPERATIONAL	OCT. '85
S	MAINTENANCE TECHNOLOGIES MISSION	
C		

0 STUDY PLAN

- 0 ASSESS MAINTENANCE TECHNOLOGY/DEVELOPMENT FOR EFFECTIVE AND COST EFFICIENT SPACE BASED MAN-MACHINE INTERFACES AND UTILIZATION
- 0 INTEGRATE WITH ON-GOING STUDIES AND TECHNOLOGY DEVELOPMENT ACTIVITIES
- 0 DEVELOP THE FEASIBILITY OF A SYSTEMS OPERATIONAL MAINTENANCE TDM FOR SPACE STATION
- 0 IDENTIFY CANDIDATE SYSTEMS AND APPLICATIONS WHICH MANDATE OR COULD BENEFIT FROM AN EARLY MAINTENANCE TDM
- 0 DEVELOP, EVALUATE AND VERIFY OPERATIONAL MAINTENANCE CONCEPTS AND SPACE STATION RESOURCE REQUIREMENTS
- 0 ASSESS THE FEASIBILITY OF ESTABLISHING A GENERIC MAINTENANCE TEST BED ABOARD THE SPACE STATION FOR ON-GOING TDM ACTIVITIES
- 0 INCORPORATE MAINTENANCE TEST BED REQUIREMENT INTO ON-BOARD WORK STATION DESIGN

	SPACE STATION SYSTEMS OPERATIONAL MAINTENANCE TECHNOLOGIES MISSION	J. LEET OCT. '85
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0 CONTRACT STATUS

- o CONTRACT NAS10-11095 WITH ROCKWELL INTERNATIONAL/KSC
- o PHASE I--STS SYSTEMS OPERATIONAL MAINTENANCE "LESSONS LEARNED"--COMPLETE
- o PHASE II -- PRIORITIZE FINDINGS FROM PHASE I, INTEGRATE WITH NEW MAINTENANCE TECHNOLOGIES/TECHNIQUES FOR SPECIFIC FOLLOW-ON APPLICATIONS
- o PERIOD OF PERFORMANCE -- JAN. '85 - JAN. '86
- o PHASE III -- INTEGRATED OPERATIONAL MAINTENANCE "LESSONS LEARNED" DATA BASE
- o PERIOD OF PERFORMANCE -- AUG. '85 - APR. '86
- o PHASE IV -- DEVELOP CANDIDATE SYSTEM OPERATIONAL MAINTENANCE TECHNOLOGIES TDM CONSIDERATIONS
- o PERIOD OF PERFORMANCE -- AUG. '85 - APR. '86

EXPERIMENT TITLE: Systems Operational Maintenance Technology

PROPOSED FLIGHT DATE - 1993 YEAR

OPERATIONAL DAYS REQUIRED - 12/90 Days

MASS - 200 KG

VOLUME:

STORED: W .760 M x L .526 M x H 2.429 M = .958 M³

DEPLOYED: W 1.0 x L 1.0 x H 2.429 M = 2.429 M³

INTERNAL ATTACHED Yes (YES/NO)

EXTERNAL ATTACHED Yes (YES/NO)

FORMATION FLYING No (YES/NO)

ORIENTATION (inertial, solar, earth, other) Any

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 1.0 Hrs/Day 2 No. of days

OPERATIONS: 6.0 Hrs/Day 2 No. of days 15 Interval

SERVICING: 0 Hrs/Day 0 No. of days 0 Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 0.5 Hrs/Day 2 No. of days

OPERATIONS: 2.0 Hrs/Day 2 No. of days 15 Interval

SERVICING: 0.5 Hrs/Day 1.0 No. of days 90 Interval

POWER REQUIRED:

3.0 KW AC or DC (circle one)

6.0 Hrs/Day 2 No. of days

DATA RATE: Min Megabits/second

DATA STORAGE: Min Gigabits

JOHN MALONEY

OTV PROXIMITY OPERATIONS

TDMX 2573

OBJECTIVE: TO PROVIDE A TECHNOLOGY BASE FOR OTV PROXIMITY OPERATIONS, INCLUDING DOCKING/BERTHING AND LAUNCH OF AN OTV AT A SPACE STATION.

DESCRIPTION: LAUNCH OPERATIONS

- DEPLOY OTV FROM STATION WITH RMS

STATION PROXIMITY OPERATIONS

- ASSESS BOTH R AND V PROXIMITY OPERATIONS

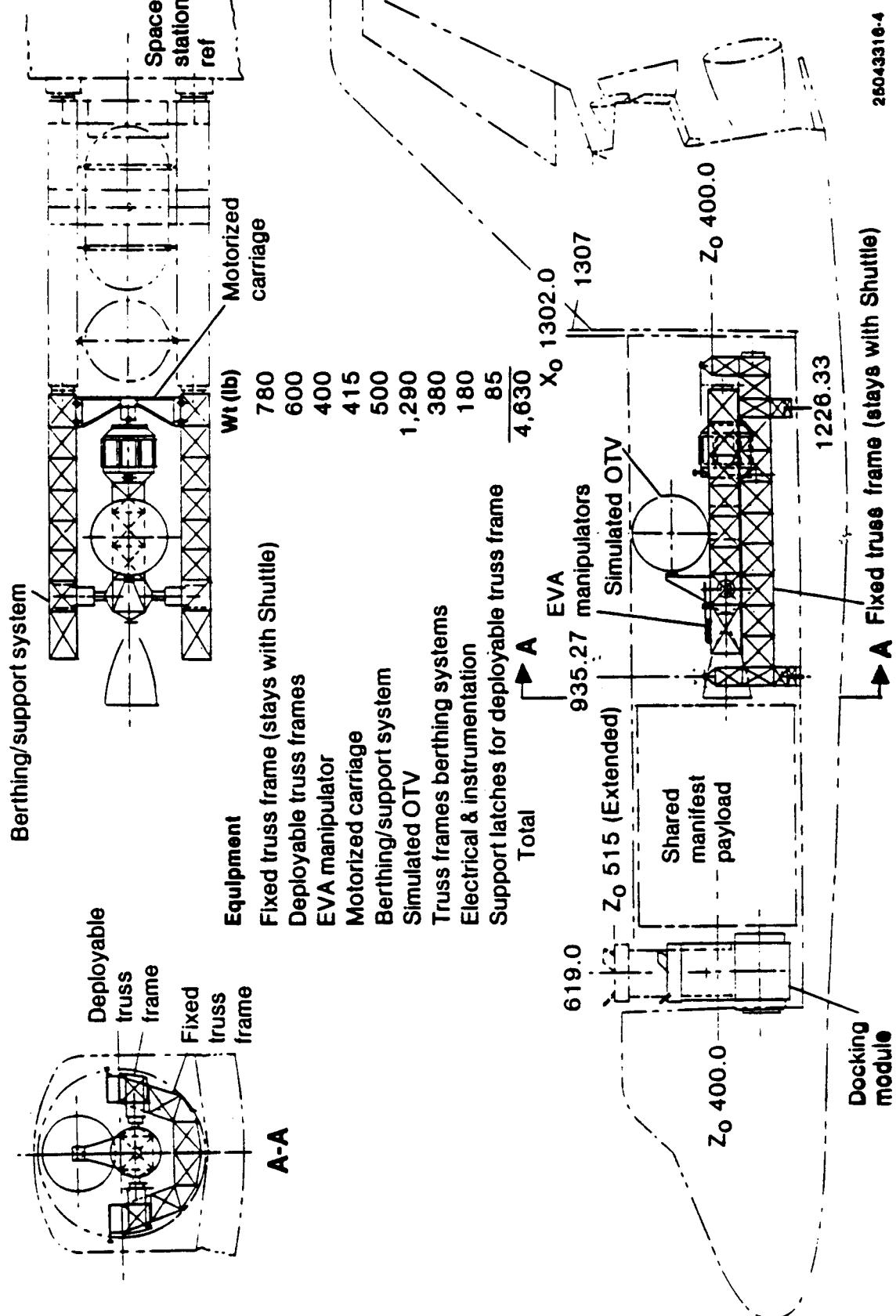
DOCKING AND BERTHING OPERATIONS

- USE OMN TO CONTROL SIMULATED OTV
- DIRECT DOCKING WITH STATION
- RMS CAPTURE OTV AT STATION

DOCKING & BERTHING TDM

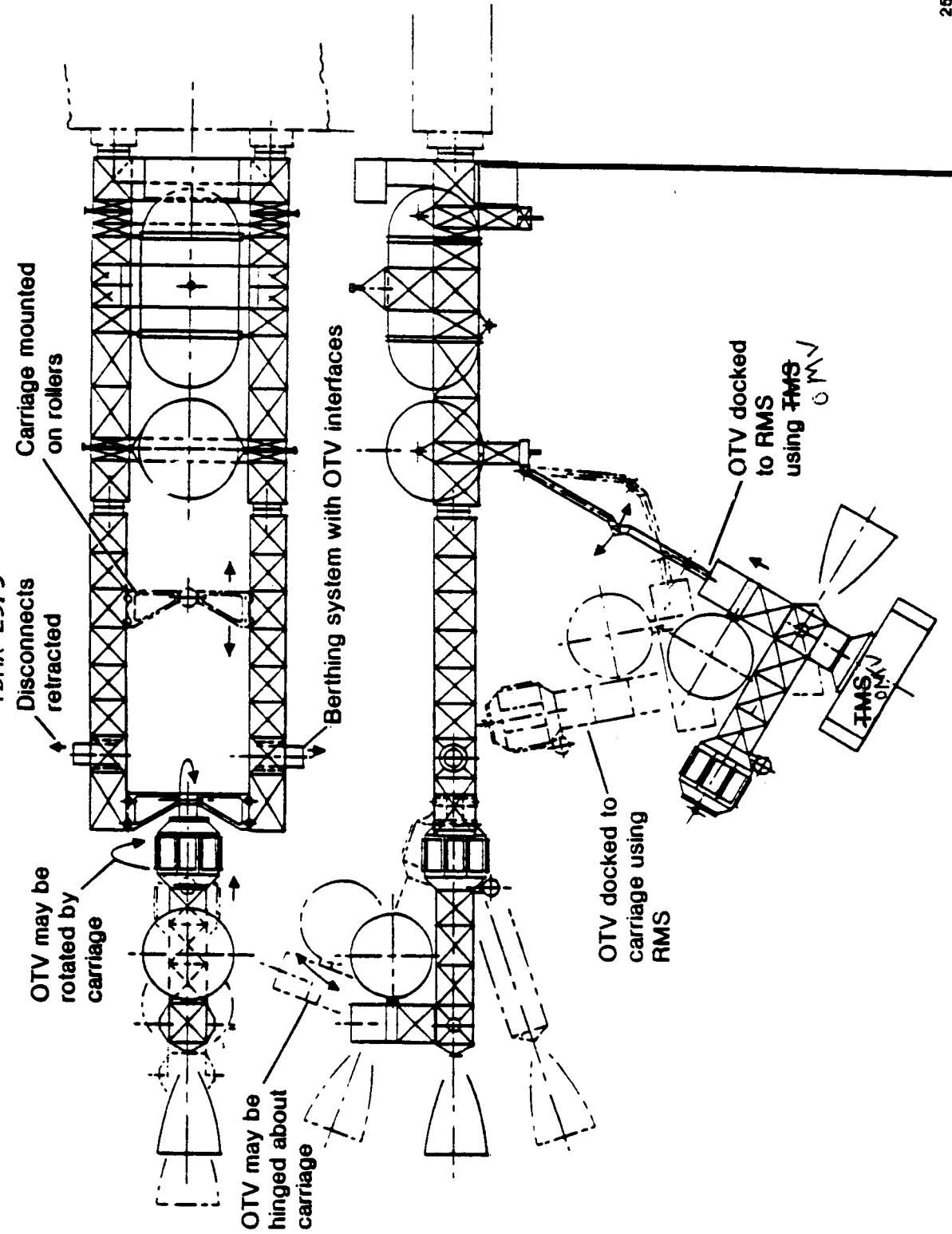
TDMX 2573

JOHN MALONEY



ALTERNATIVE DOCKING OPERATION

TDMX 2573



GENERAL DYNAMICS
Space Systems Division

JOHN MALONEY

EXPERIMENT TITLE: OTV PROXIMITY OPERATIONS TDMX 2573

PROPOSED FLIGHT DATE - APRIL 1993 YEAR

OPERATIONAL DAYS REQUIRED - 14

MASS - 9900 2100 KG + OMV

VOLUME:

STORED: W 9.8 x L 8.6 x H _____ = 200 M³

DEPLOYED: W 9.7 x L 7.4 x H 4.8 = 903 M³

INTERNAL ATTACHED NO (YES/NO)

EXTERNAL ATTACHED YES (YES/NO)

FORMATION FLYING NO (YES/NO)

ORIENTATION (inertial, solar, earth, other) EARTH

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 2 Hrs/Day 1 No. of days

OPERATIONS: _____ Hrs/Day _____ No. of days _____ Interval

SERVICING: 2 Hrs/Day 12 No. of days 2D Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 8 Hrs/Day 2 No. of days

OPERATIONS: 6 Hrs/Day 12 No. of days 2D Interval

SERVICING: 2 Hrs/Day 12 No. of days 2D Interval

POWER REQUIRED:

0.5 KW AC or DC (circle one)

8 Hrs/Day 14 No. of days

DATA RATE: 2.5 Megabits/second

DATA STORAGE: 4.5 Gigabits

OTV MAINTENANCE TECHNOLOGY
TDMX 2574

JOHN MALONEY

OBJECTIVE: TO PROVIDE A TECHNICAL BASE FOR THE DEVELOPMENT OF THE CAPABILITY TO SERVICE AND MAINTAIN AN OTV ON ORBIT. BOTH AUTOMATED AND EVA MAINTENANCE CAPABILITY WILL BE EVALUATED.

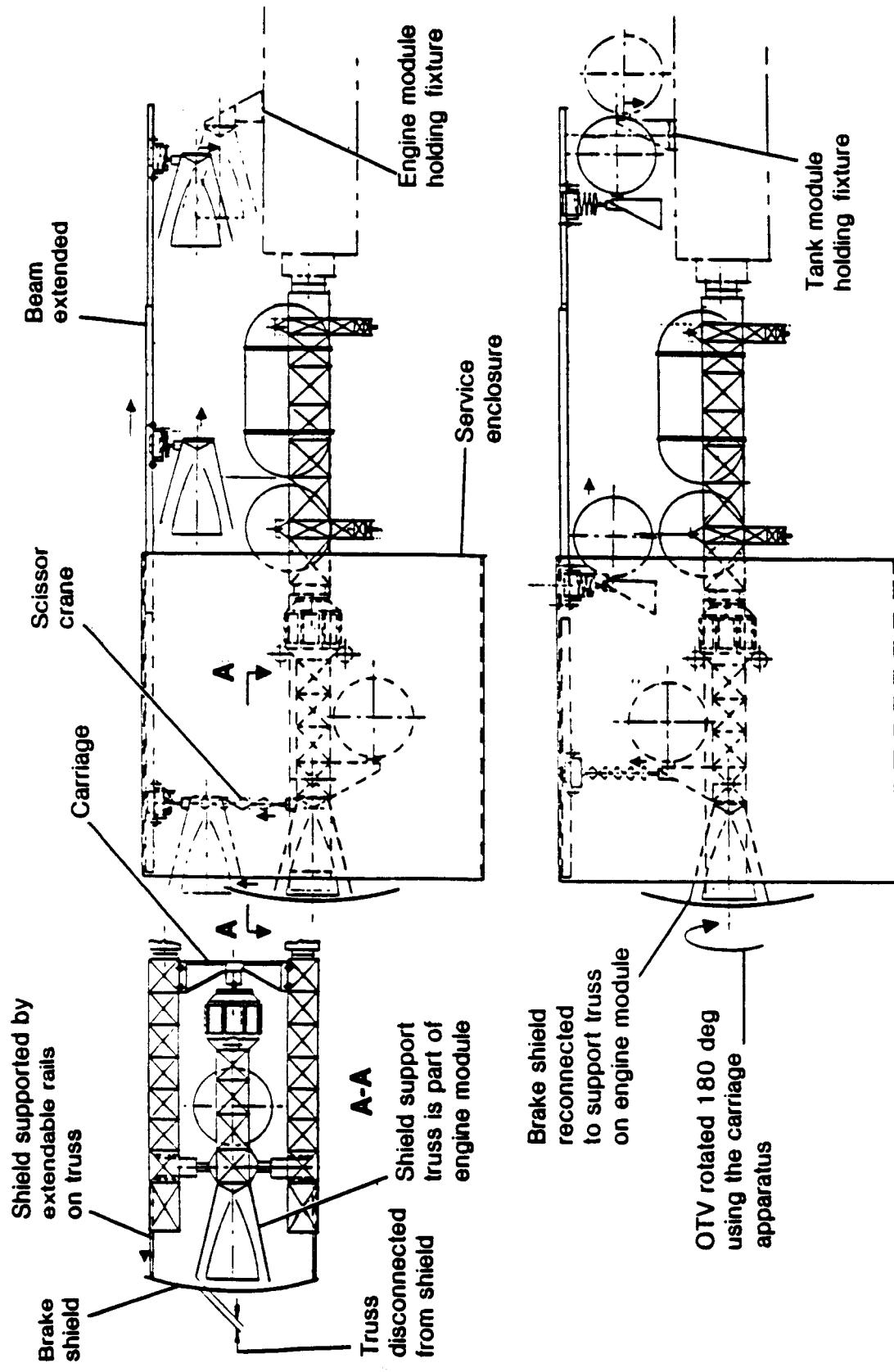
DESCRIPTION: ASSESS MAINTENANCE RELATED FUNCTIONS, FACILITIES AND EQUIPMENT

- OTV MAINTENANCE DOCK HANDLING OPERATIONS
- SERVICE ENCLOSURE OPERATIONS
- VISUAL INSPECTION
- OTV COMPONENT REPLACEMENT OPERATIONS (RMS)
- OTV COMPONENT REPLACEMENT OPERATIONS (EVA)

MAINTENANCE TDM — ENGINE & TANK CHANGEOUT

TDMX 2574

JOHN MALONEY



JOHN MALONEY

EXPERIMENT TITLE: OTV MAINTENANCE TECHNOLOGY TDMX2574

PROPOSED FLIGHT DATE - JULY 1993 YEAR

OPERATIONAL DAYS REQUIRED - 38

MASS - 3300 KG + TDMX 2573

VOLUME:

STORED: W x L x H = M³

DEPLOYED: W 13 x L 11 x H 13 = 1859 M³

INTERNAL ATTACHED NO (YES/NO)

EXTERNALLY ATTACHED YES (YES/NO)

FORMATION FLYING NO (YES/NO)

ORIENTATION (inertial, solar, earth, other) NOT CRITICAL

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 7 Hrs/Day 2 No. of days

OPERATIONS: 8 Hrs/Day 18 No. of days 4D Interval

SERVICING: Hrs/Day No. of days Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 8 Hrs/Day 2 No. of days

OPERATIONS: 8 Hrs/Day 36 No. of days 2D Interval

SERVICING: Hrs/Day No. of days Interval

POWER REQUIRED:

1.6 KW AC or DC (circle one)

8 Hrs/Day 38 No. of days

DATA RATE: 1.3 Megabits/second

DATA STORAGE: 2.4 Gigabits

NASA/MSFC

TDM 2561

SATELLITE SERVICING AND REFURBISHMENT

EXPERIMENT OBJECTIVE

TO DEMONSTRATE AND VERIFY THE CAPABILITY TO REFURBISH AND RESUPPLY LEO OPERATIONAL SATELLITES FROM THE SPACE STATION USING SPACE STATION. A SATELLITE ON-ORBIT WHOSE NOMINAL MISSION IS COMPLETE WILL BE USED. (GRO IS A POSSIBILITY.) WHEN THE TDM IS COMPLETE THE SATELLITE WILL BE RETURNED TO ITS ORBIT.

NASA/MSFC

TDM 2561

SATELLITE SERVICING AND REFURBISHMENT

EXPERIMENT DESCRIPTION

THE SATELLITE IS RETRIEVED FROM ITS ORBIT AND BROUGHT TO THE SPACE STATION. WHEN IN SPACE STATION PROXIMITY THE SATELLITE IS RETRIEVED AND BERTHED IN THE SATELLITE SERVICING FACILITY. SERVICING WILL INCLUDE ORU CHANGEOUT, REFUELING AND OTHER REPAIR/REFURBISHMENT. THE SERVICING OPERATIONS MAY BE ACTUALLY NEEDED OR MAY BE SIMULATED.

Satellite Maintenance and Repair—TDM 2561

MISSION OBJECTIVE

THE OBJECTIVE OF THIS MISSION IS TO DEMONSTRATE THE CAPABILITY TO RETRIEVE SATELLITES AND CONDUCT REPAIR, RESUPPLY AND PETROFIT (RR&R) OPERATIONS AT THE SPACE STATION SERVICING FACILITY. DEMONSTRATION OF THE SUPPORT FACILITIES AND EQUIPMENT REQUIRED TO EXTEND THE OPERATIONAL LIFETIME OR UPGRADE EXISTING SPACECRAFT / EXPERIMENT ELEMENTS WILL ACCELERATE THE PROCESS OF DESIGNING SATELLITES FOR RR&R.

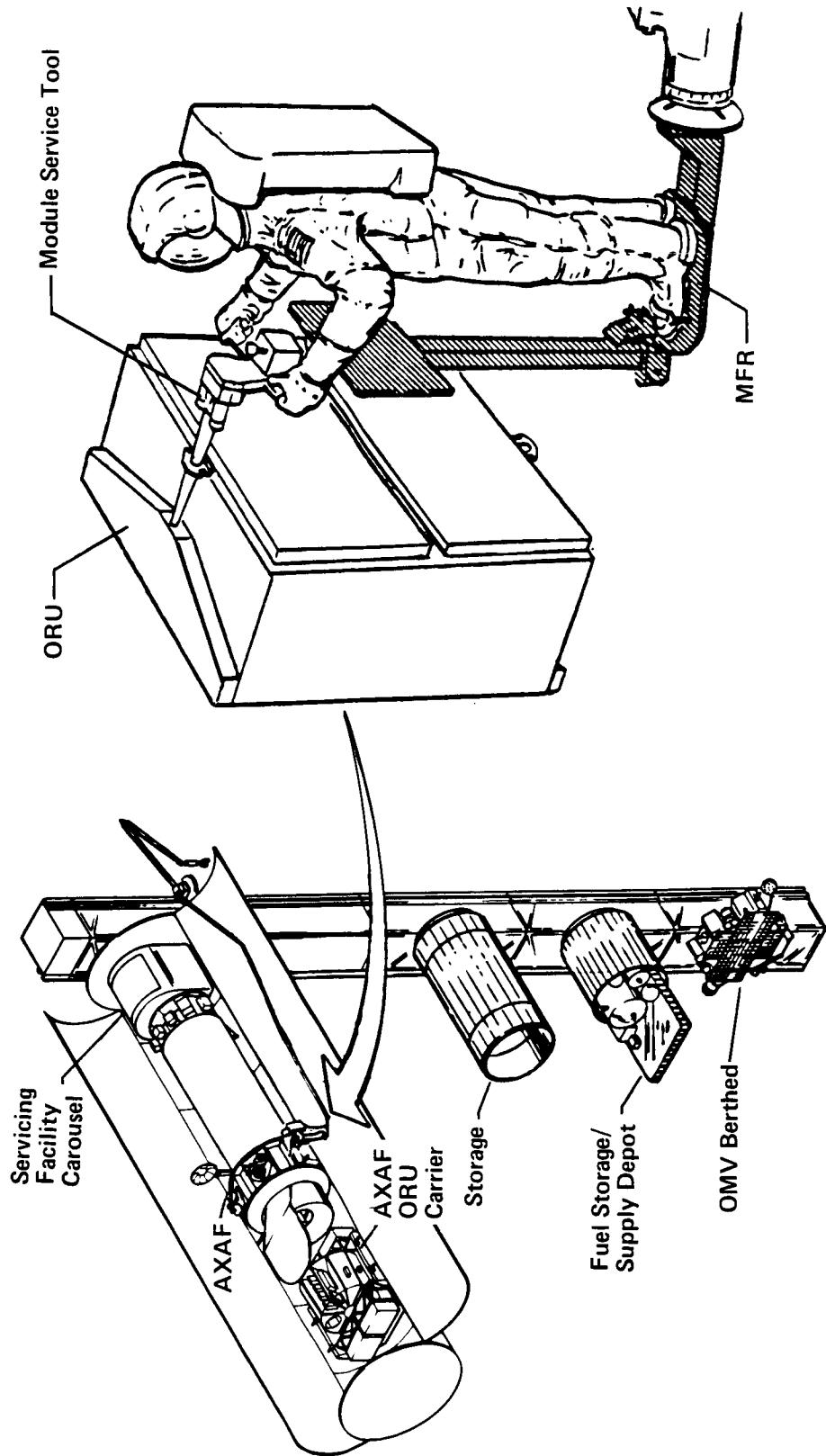
EXPERIMENT DESCRIPTION

THIS TECHNOLOGY DEMONSTRATION WILL INCLUDE ALL OF THE OPERATIONS NECESSARY TO PREPARE AND LAUNCH A SPACE STATION ORBITAL MANEUVERING VEHICLE TO RECOVER A HIGH FIDELITY MOCKUP OF THE ADVANCED X-RAY ASTROPHYSICS FACILITY (AXAF). AND RETURN AND BERTH THE AXAF MOCKUP IN THE SPACE STATION SERVICING FACILITY. THE MOCKUP WILL THEN BE SERVICED BY EVA, USING RR&R PROCEDURES, INCLUDING USE OF SERVICE HANGAR, TOOLS- AND ORBITAL RESUPPLY UNIT (ORU). FOLLOWING REFURBISHMENT OF OMV AND CHECKOUT OF REPAIRED, RESUPPLIED AND PETROFITTED AXAF, OMV WILL BE MATED AND AXAF MOCKUP TRANSFERRED TO SIMULATED NEW OPERATIONAL ORBIT.

DJCK CABLE (303) 977-6108

MARTIN MARIETTA

Satellite Maintenance and Repair—TDM 2561



Satellite Maintenance and Repair—TDM 2561

PROPOSED FLIGHT DATE - 1994
OPERATIONAL DAYS REQUIRES - 2 DAYS
MASS - SPAS - HI-FIDELITY AXAF MOCKUP - 2000 KG
VOLUME:

STORED: $W-\underline{1} \times L-\underline{4} \times H-\underline{1} = 4 \text{ m}^3$

DEPLOYED: $W-\underline{1} \times L-\underline{4} \times H-\underline{1} = 4 \text{ m}^3$

INTERNAL ATTACHED: YES

EXTERNALLY ATTACHED: NO

FORMATION FLYING: YES

ORIENTATION: INERTIAL

EXTRA VEHICULAR ACTIVITY REQUIRED:

SETUP: $\frac{4}{4} \text{ HRS/DAY}$ $\frac{2}{2} - \text{NO OF DAY}$

OPERATIONS: $\frac{16 - 20}{16 - 20} \text{ HRS/DAY}$ $\frac{2}{2} - \text{NO OF DAYS}$ — INTERVAL

SERVICING: $\frac{—}{—} \text{ HRS/DAY}$ $\frac{—}{—} \text{NO OF DAYS}$ — INTERVAL

INTRA-VEHICULAR ACTIVITY REQUIRED:

SETUP: $\frac{12}{12} \text{ HRS/DAY}$ $\frac{2}{2} - \text{NO OF DAYS}$

OPERATIONS: $\frac{16 - 20}{16 - 20} \text{ HRS/DAY}$ $\frac{2}{2} - \text{NO OF DAYS}$ — INTERVAL

SERVICING: $\frac{—}{—} \text{ HRS/DAY}$ $\frac{—}{—} \text{NO OF DAYS}$ — INTERVAL

POWER REQUIRED:

TBD KW AC OR DC

16 - 20 HRS/DAY $\frac{2}{2} - \text{NO OF DAYS}$

DATA RATE TBD DATA STORAGE TBD

DICK CABLE (303) 977-6108

MARTIN MARIETTA

Materials Resupply—TDM 2563

MISSION OBJECTIVE

THE OBJECTIVE OF THIS TDM IS TO VALIDATE AND DEMONSTRATE THE CAPABILITY TO RESUPPLY MATERIALS PROCESSING SYSTEMS AT LOCATIONS REMOTE FROM THE SPACE STATION. THIS TDM WILL DEMONSTRATE RETRIEVAL AND REPLACEMENT OF MODULES LOCATED AT PLATFORMS AND FREE FLYING SATELLITE SYSTEMS USING AUTOMATED PROCESSES, RATHER THAN EVA. CURRENT MATERIALS PROCESSING PLANNERS ASSERT THAT LARGE SCALE ROUTINE MODULE REPLACEMENT WILL BE ESSENTIAL TO PROFITABLE ONORBIT OPERATIONS.

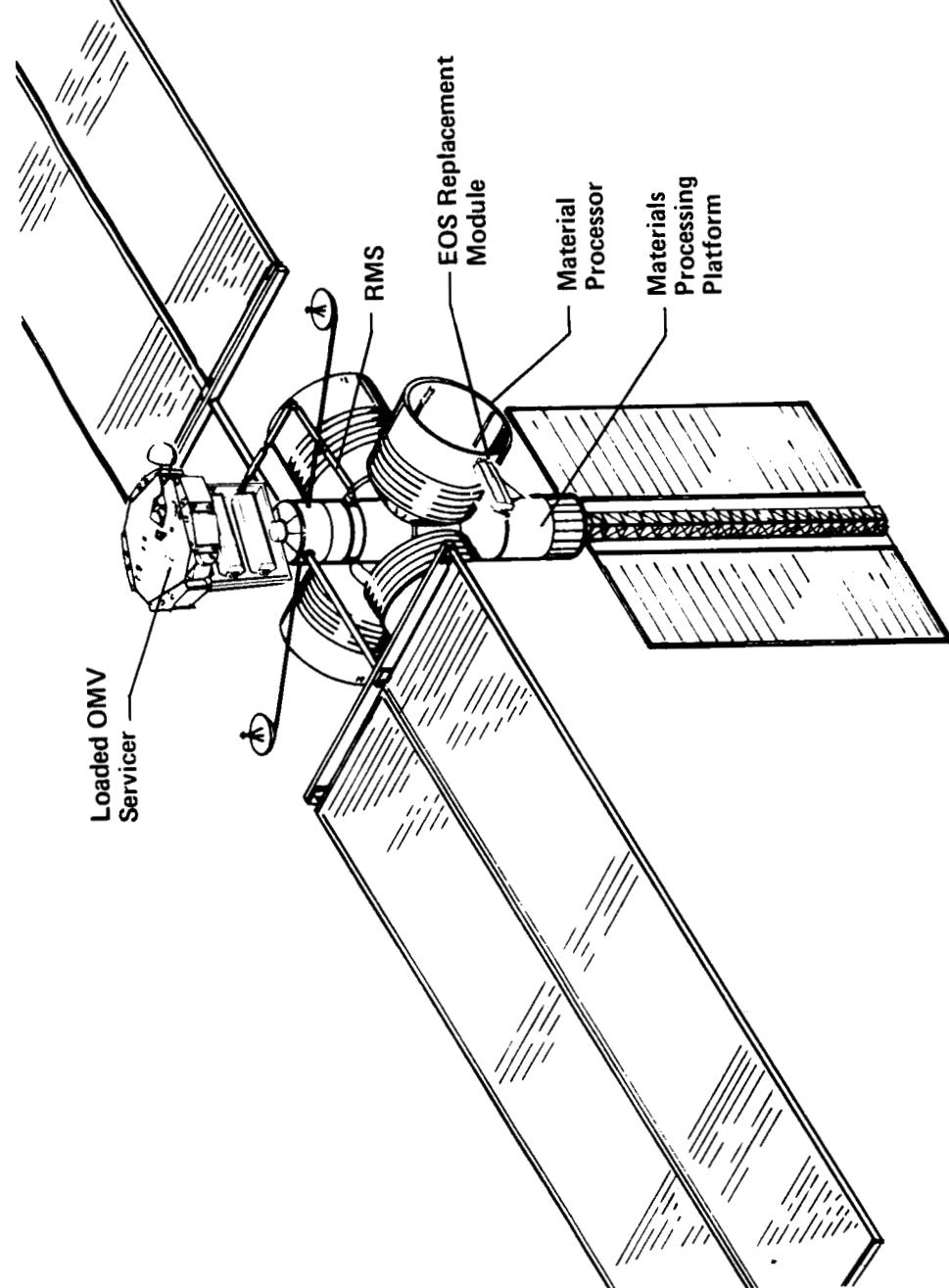
EXPERIMENT DESCRIPTION

THIS TECHNOLOGY DEMONSTRATION WILL INVOLVE RETRIEVAL OF FINISHED PRODUCT FROM A MATERIALS PROCESSING SYSTEM (MPS) AT A LOCATION REMOTE FROM SPACE STATION. USING THE ORBITAL MANEUVERING VEHICLE. THE MATERIALS PROCESSING PLATFORM WILL BE A CO-ORBITING SATELLITE WITHIN RF LINE OF SIGHT OF THE SPACE STATION. AND ALL PROCEDURES WILL BE DIRECTED BY SPACE STATION COMMAND CENTER. THE TDM WILL INCLUDE: 1) FUELING THE OMV, 2) LOADING A MULTI-PURPOSE TRANSPORTER/SERVICER UNIT WITH (MPS) REPLACEMENT MODULES, 3) MATING THE OMV WITH THE LOADED SERVICER UNIT, 4) OMV LAUNCH AND RENDEZVOUS AND DOCK WITH THE PLATFORM, 5) EXCHANGING THE MPS MODULES, 6) CHECKOUT OF MPS, 7) RETURN TO SPACE STATION, 8) STORAGE OF MPS MODULES, AND 9) REFURBISHMENT OF OMV.

DICK CABLE (303) 977-6108

MARTIN MARIETTA

Materials Resupply—TDM 2563



Materials Resupply—TDM 2563

PROPOSED FLIGHT DATE - 1993

OPERATIONAL DAYS REQUIRED - 1 DAY

MASS: 28,000 KG - (4 - 15,000 LB MODULES, 1 - 2000 LB TRANSPORTER)

VOLUME:

STORED: 4 MODULES - 1M THICK x 2M DIAMETER = 30 M³

DEPLOYED: 4 MODULES - 1M THICK x 2M DIAMETER = 30 M³

INTERNAL ATTACHED: YES

EXTERNALLY ATTACHED: YES

FORMATION FLYING: NO

ORIENTATION: INERTIAL

EXTRA VEHICULAR ACTIVITY REQUIRED:

NONE, ALL OPERATIONS WITH OMV, TRANSPORTER/SERVICER AT SPACE STATION DONE BY AUTOMATION AND ROBOTICS, BOTH PRIOR TO LAUNCH AND UPON RETURN OF PROCESSED MATERIALS TO SPACE STATION

INTRA-VEHICULAR ACTIVITY REQUIRED:

SETUP: 4 HRS/DAY 1 - NO OF DAYS

OPERATIONS: 16 HRS/DAY 1 - NO OF DAYS

SERVICING: - HRS/DAY - - NO OF DAYS

POWER REQUIRED:

TBD KW AC OR DC

TBD HRS/DAY TBD - NO OF DAYS

DATA RATE: TBD

DATA STORAGE: TBD

MARTIN MARIETTA

Coatings Maintenance—TDM 2564

MISSION OBJECTIVE

THE OBJECTIVE OF THIS MISSION IS THE DEMONSTRATION OF ONORBIT EXTERNAL SPACE STATION SYSTEM REFURBISHMENT USING ACTIVE BEAM TECHNOLOGY. THE EXPERIMENT WILL TEST EQUIPMENT AND PROCEDURES FOR CLEANING, RESURFACING AND RECOATING DEGRADED SURFACES. THESE PROCEDURES WILL EXTEND THE USEFUL LIFE OF SPACE STATION AND SATELLITE SYSTEMS SUCH AS, THERMAL RADIATORS, SOLAR ARRAYS, OPTICAL SYSTEMS, AND VIEWPORTS.

EXPERIMENT DESCRIPTION

9

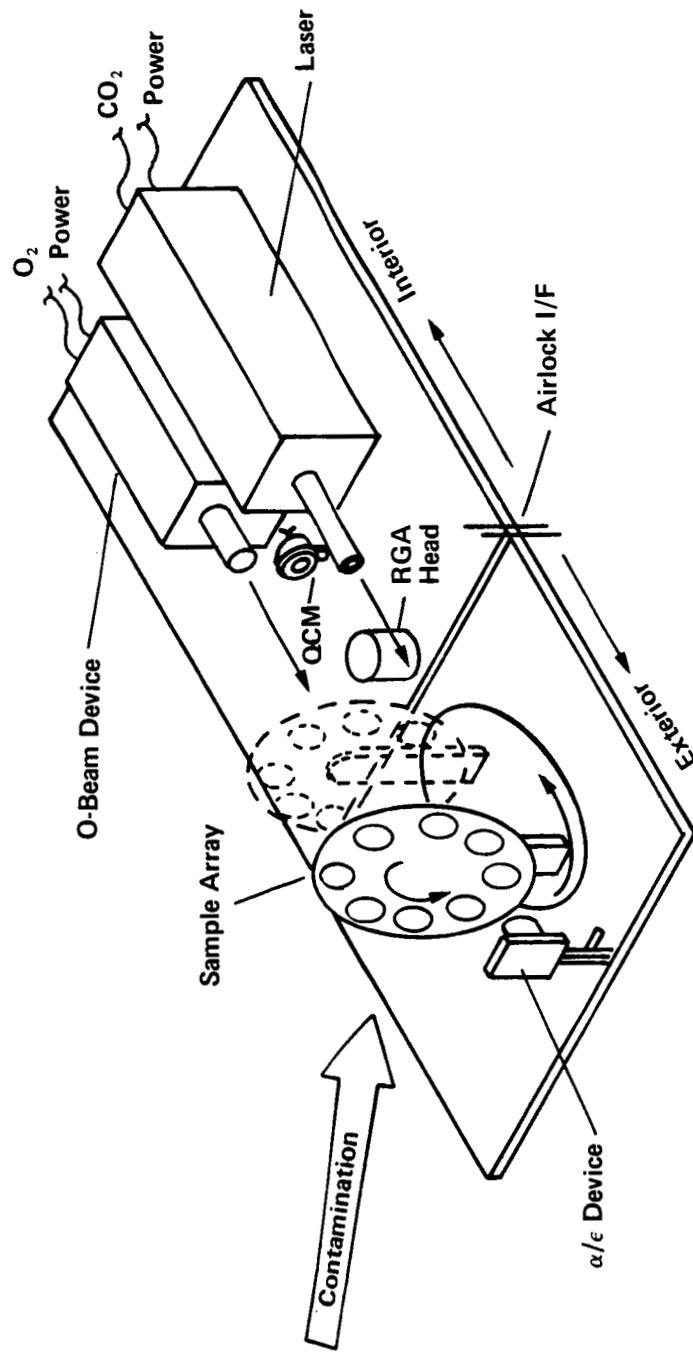
THIS TDM WILL UTILIZE ACTUAL SPACE STATION MATERIALS AND SURFACES, OR SCALED DOWN TEST FIXTURE SURFACES, FOR TESTING PROCEDURES AND MATERIALS INVOLVED IN SURFACE DEGRADATION AND CONTAMINATION MAINTENANCE ACTIVITIES. THE SELECTED RANGE OF COATED SURFACES IN USE AT SPACE STATION WILL BE REFURBISHED USING A HIGH ENERGY BEAM SYSTEM (TBD). AN EXPERIMENTAL PLATFORM FITTED WITH AN ARRAY OF COATED SURFACES WILL BE EXPOSED TO THE SPACE ENVIRONMENT IN THE IMMEDIATE VICINITY OF THE ORBITING SPACE STATION TO ASSESS CONTAMINATION AND DEGRADATION FACTORS. THIS EXPOSURE WILL EXTEND FOR SEVERAL MONTHS, BEFORE AND AFTER RECOATING EXPERIMENTS.

THE HIGH ENERGY REFURBISHMENT SYSTEM CONFIGURATION INVOLVES THE USE OF: 1) A LASER FOR SILICON BASED MATERIALS, AND HIGH ENERGY OXYGEN FOR HYDROCARBON MATERIALS, OR 2) A SINGLE LASER SYSTEM EFFECTIVE ON A WIDE RANGE OF MATERIALS.

LYLE RAPTESS (303) 977-8717

MARTIN MARIETTA

Coating Maintenance—TDM 2564



Coating Maintenance Technology Payload Element

Coatings Maintenance—TDM 2564

PROPOSED FLIGHT DATE - 1992 - 1993

OPERATIONAL DAYS REQUIRED - 5 DAYS

MASS - 64KG

VOLUME:

STORED: $W_{-1M} \times L_{-2.5M} \times H_{-1M} = 2.5 \text{ m}^3$

DEPLOYED: $W_{-1M} \times L_{-2.5M} \times H_{-1M} = 2.5 \text{ m}^3$

INTERNAL ATTACHED - NO

EXTERNALLY ATTACHED - YES

FORMATION FLYING: NO

ORIENTATION: ANY

EXTRA VEHICULAR ACTIVITY REQUIRED:

NONE, AUTOMATED INSTALLATION

INTRA-VEHICULAR ACTIVITY REQUIRED:

SETUP: $\underline{3}$ HRS/DAY $\underline{1}$ - NO OF DAYS

OPERATIONS: $\underline{1}$ HRS/DAY $\underline{5}$ - NO OF DAYS $\underline{90}$ -DAY INTERVAL

SERVICING: $\underline{2}$ HRS/DAY $\underline{1}$ - NO OF DAYS $\underline{30}$ -DAY INTERVAL

POWER REQUIRED:

TBD KW AC OR DC

TBD HRS/DAY TBD NO OF DAYS

DATE RATE: .001 MB/SEC DATA STORAGE .007 GB

LYLE KARIES (303) 977-8713

MARTIN MARIETTA

**GROWTH OF THIN SINGLE CRYSTAL
FILMS OF RHODIUM**

Jag J. Singh

NASA Langley Research Center

Hampton, Virginia

and

Jon J. Spijkerman

Ranger Scientific Company

Burleson, Texas

EXPERIMENTAL OBJECTIVES

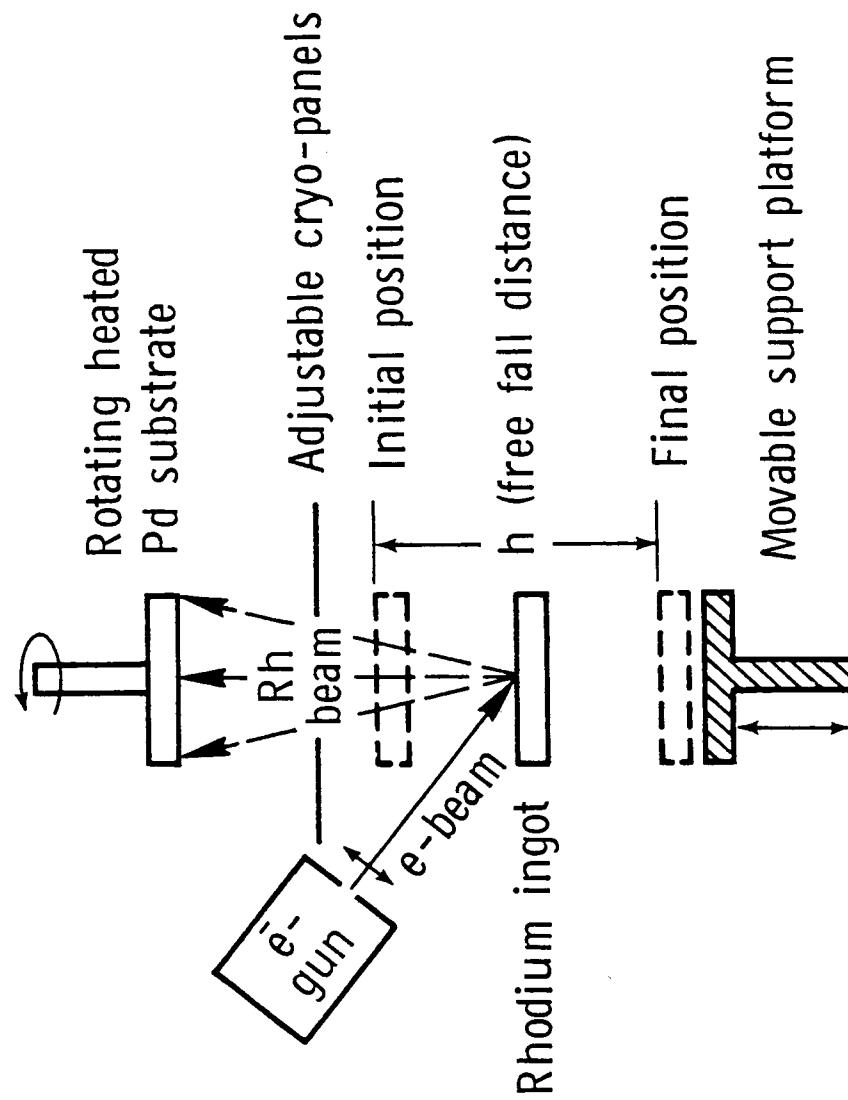
- Develop techniques for the growth of thin single crystal films of Rhodium by molecular beam epitaxial growth process in the microgravity environment onboard the space station
- Transmute selected Rhodium films into palladium by $\text{Rh}^{103}(\text{p}, \text{n}) \text{Pd}^{103}$ reaction in a terrestrial laboratory (VDG/Cyclotron Lab)
- Develop $\text{Pd}^{103}-\text{Rh}^{103}$ Mossbauer grivitometer for use in aerial and/or bore-hole surveys on earth

EXPERIMENTAL PROCEDURE

Adapt an MBE crystal growth system for making an effectively wall-less Rhodium effusion cell

- Arrange electron beam heating of Rhodium charge falling freely through a preselected distance
- Repeat this "free fall evaporation" process until a Rhodium film of 500Å-1000Å thickness is produced
- Periodically monitor the crystalline quality of the Rhodium films by low energy and high energy electron diffractometry
- If necessary, adjust the palladium substrate temperature and energy/intensity of the heating electron beam for appropriate Rhodium film production

**SCHEMATIC DIAGRAM OF THE FREELY FALLING
ELECTRON BEAM RHODIUM DEPOSITION SOURCE**



EXPERIMENT TITLE: Growth of Thin Single Crystal Films of Rhodium

PROPOSED FLIGHT DATE - 1990-1992 YEAR (first year of operation)

OPERATIONAL DAYS REQUIRED - 10

MASS - 1.0 KG

VOLUME: *

STORED: W 0.15 x L 0.15 x H 0.15 = 0.0034 M³

DEPLOYED: W 0.15 x L 0.15 x H 0.15 = 0.0034 M³

INTERNAL ATTACHED ✓ (YES/NO)

EXTERNALLY ATTACHED _____ (YES/NO)

FORMATION FLYING _____ (YES/NO)

ORIENTATION (inertial, solar, earth, other) Inertial or earth

EXTRA-VEHICULAR ACTIVITY REQUIRED: None

SET-UP: _____ Hrs/Day _____ No. of days

OPERATIONS: _____ Hrs/Day _____ No. of days _____ Interval

SERVICING: _____ Hrs/Day _____ No. of days _____ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED: None

SET-UP: _____ Hrs/Day _____ No. of days

OPERATIONS: _____ Hrs/Day _____ No. of days _____ Interval

SERVICING: _____ Hrs/Day _____ No. of days _____ Interval

POWER REQUIRED:

10 KW AC or DC (circle one)

4 Hrs/Day 10 No. of days

DATA RATE: N/A Megabits/second

DATA STORAGE: N/A Gigabits

* It is assumed that the materials processing facility onboard the space station will have an MBE crystal growth system.



MANNED SYSTEM EXPERIMENT CANDIDATES

PRESENTATION TO:

IN-SPACE RESEARCH , TECHNOLOGY AND
ENGINEERING (RT&E) WORKSHOP

IN-SPACE OPERATIONS

■ - 10 OCTOBER 1988

H. T. FISHER, MGR

CREW SYSTEMS
BIOASTRONAUTICS
SPACE STATION PROGRAM

ASTRONAUTICS DIVISION
Lockheed Missiles & Space Company, Inc.
1111 LOCKHEED WAY SUNNYVALE, CALIFORNIA 94086-3504



PURPOSE AND OBJECTIVES

PURPOSE

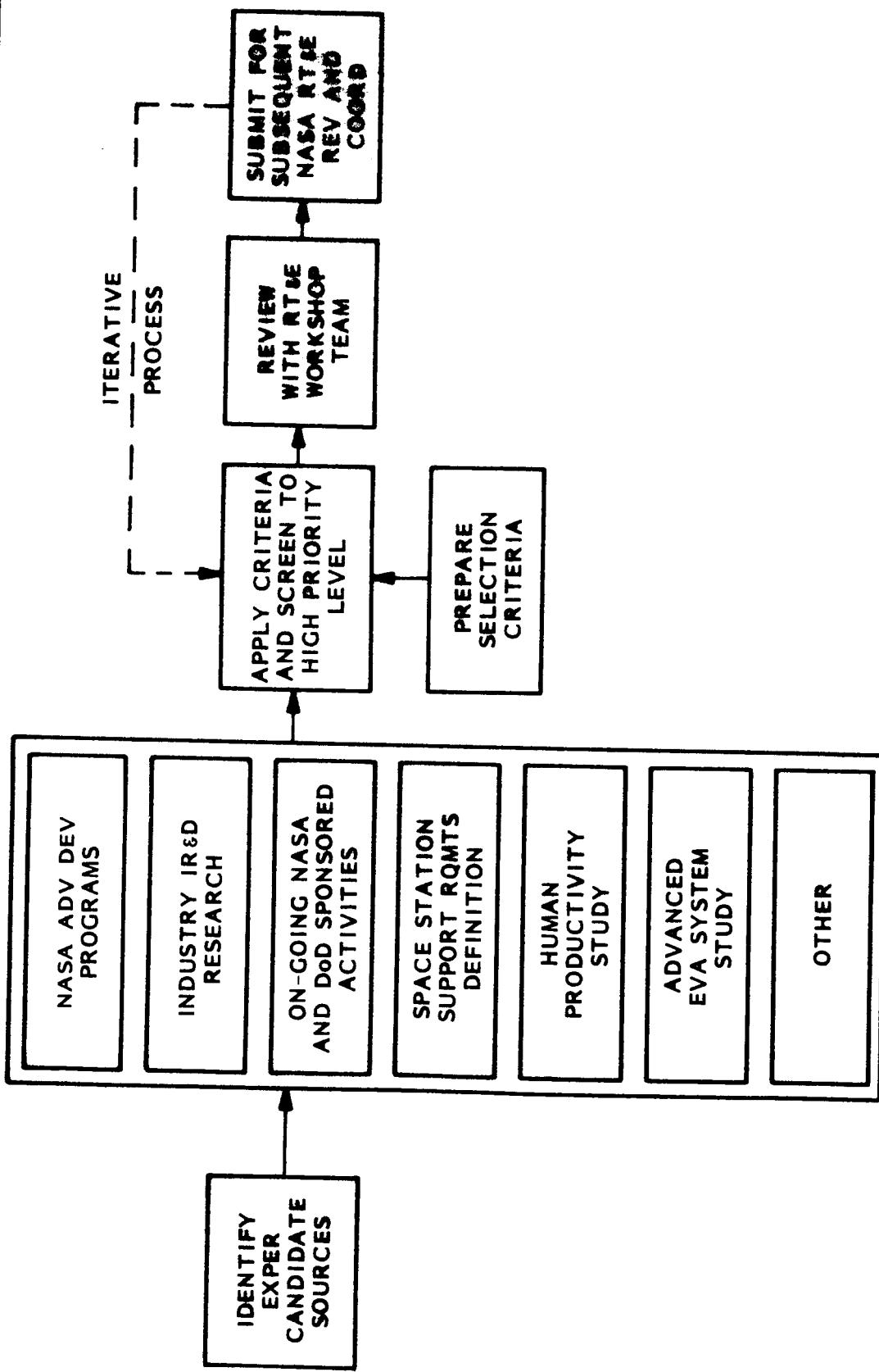
- IDENTIFY CANDIDATE MANNED SYSTEM EXPERIMENTS
FOR IN-SPACE RT&E CONSIDERATION

OBJECTIVES

- AID IN VALIDATING RT&E THEMES AS MECHANISM TO
FACILITATE PLANNING AND COORDINATION
- IDENTIFY PRE-CURSOR SPACE SHUTTLE EXPERIMENTS
- PROVIDE EXPERIMENT DESCRIPTIVE DATA



SPACE CANDIDATE REPRESENTATIVE SELECTION CRITERIA





TYPICAL RT&E SELECTION CRITERIA

1. DEVELOPMENT OF TECHNIQUES FOR CONTINUED HEALTH AND WELL BEING OF CREW
2. MAINTENANCE AND/OR ENHANCEMENT OF ON-ORBIT HUMAN PRODUCTIVITY
3. ENABLING OF 1-G LIMITED RESEARCH AND TEST /VERIFICATION
4. DEMONSTRATION OF MAN'S CONTRIBUTION TO ORBITAL SUPPORT FUNCTIONS
5. DEVELOPMENT OF MANNED-SUPPORTED TECHNIQUES TO ENHANCE AND/OR REDUCE HARDWARE COSTS



CANDIDATE MANNED SYSTEM EXPERIMENTS

INFORMATION NEEDS / EXPERIMENT	PROP. FLIGHT DATE	OPS DAYS REQD	MASS (KG)	STOW VOLUME			DEPLOY VOLUME			ATTACHED	FREE FLY	ORIENT.
				W	L	H	M ³	W	L	H	M ³	
A. IVA 1. FLT CREW • SPACE ADAPT SYNDROM	1992		225				.257	.257			YES - INTERNAL	NO
• MUSCULAR STRENGTH & ENDURANCE	1992	7	70				1.748	1.748			YES - INTERNAL	N/A
• BONE DEMINERALIZATION MINIMIZATION		3	150				1.134	1.134			YES - INTERNAL	NO
B. IVA 1. CREW OPS - PRODUCTIVITY	*1988 / 1993	5/90	63	18	16	28	-0.1	18	24	28 ~0.1	YES - INTERNAL	ANY
• ON-ORBIT WATER MANAGEMENT	1992	13	9.9	18	24	18	-0.1	18	36	18 ~0.1	YES - INTERNAL	ANY
• CONTAMINATION CLEANING TECH												

* SHUTTLE



CANDIDATE MANNED SYSTEM EXPERIMENTS

EXPERIMENT	INFORMATION NEEDS				IVA				POWER				DATA RATE		DATA STORAGE	
	SET-UP HRS/ DAY	OPS NO. DAYS/DAY	SERV NO. DAYS/DAY	SET-UP HRS/ NO. DAYS/DAY	OPS NO. DAYS/DAY	SERV NO. DAYS/DAY	KW	HRS/ DAY	MON DC	MON AC	W DC	W AC	VAR	0	0	CIGABITS
A. IVA 1. FLT CREW • SPACE ADAPT SYNDROM				1 / 5	14	1	14	1	3 WKY	1	3 MON	1	14			281 M
• MUSCULAR STRENGTH AND ENDURANCE					4 1/2	14	1	14	1 WKY	1	3 MON	4	1/2	14		4.3 M
• BONE DEMINERALIZATION MINIMIZATION				1 / 2	14	8	14	0	0 WKY	0	0 WKY	24	14	0	0	
B. IVA 1. CREW OPS - PRODUC-TIVITY	0.1	5 / 26	0.5	5 / 26	1	1 / 3	0.01	0.5	0 AC	0	0	0	0	0	0	0
• ON-ORBIT WATER MGMT																
• CONTAMINATION CLEAN-ING TECH	0.1	2	4	2	0	0	0 VAR	0	0	0	0	0	0	0	0	



CANDIDATE MANNED SYSTEM EXPERIMENTS (Cont)

INFORMATION NEEDS EXPERIMENT	PROP. FLIGHT DATE	OPS DAYS REQD	MASS (KG)	STOW VOLUME			DEPLOY VOLUME			ATTACHED	FREE FLY	ORIENT.
				W	L	H	M ³	W	L	H		
B. IVA (CONT) ● REPAIR (ELECT/GAS TECHNIQUES)	*1988/ 1992		14.4	18	12	24	~0.1	18	24	~0.1	YES- INTERNAL	ANY
	1992	13	27.0	18	16	30	~0.2	18	24	~0.2	YES- INTERNAL	ANY
	*1987/ 1992	14/90	189/ 1,215	.5	.5	.25~30	.5	.5	.25~30	YES- INTERNAL	ANY	
C. EVA 1. EVA OPS/DEMO ● JOINT/ STRUCTURE BUILDUP	*1988/ 1994	2/4	540	56	120	12	~1.3	9	9	~20	YES- EXTER.	ANY
	*1988/ 1993	3/14	36	16	16	36	~0.15	16	32	~0.2	YES- EXTER.	ANY
	1994	4	180	60	48	36	2	60	60	36	2.1	YES- EXTER.

* SHUTTLE



CANDIDATE MANNED SYSTEM EXPERIMENTS (Cont)

INFORMATION NEEDS EXPERIMENT	EVA				IVA				POWER			DATA RATE MEG/ SEC	
	SET-UP HRS/ NO. DAYS DAY	OPS HRS/ NO. DAYS DAY	SERV HRS/ NO. DAYS DAY	SET-UP HRS/ NO. DAYS DAY	OPS HRS/ NO. DAYS DAY	SERV HRS/ NO. DAYS DAY	KW	HRS/ DAY	NO. OF DAYS	DATA STORAGE GIGABITS			
B. IVA (CONT)													
• REPAIR (ELECT/ GAS TECH)													
• INTERNAL CABIN WALL/EN- CLOSURE CLEANING				.1	13	4	.12	.5	12	1/50 AC	5	12	
• FOOD PACKAGING													
C. EVA													
1. EVA OPS/ DEMO													
• JOINT / STRUCTURE BUILDUP	1	4	6	4	0	0			0	0	0	0	
• MATERIALS	1	14	6	14 (6)	.1	14 (6)				1/50 DC	6	14	
• JOINING A&R CREW RESCUE UNIT	.5	4	2	4 CON	12	4 CON				7 AC	3	4	



CONCLUSIONS/RECOMMENDATIONS

CONCLUSIONS

- CANDIDATE EXPERIMENTS REQUIRED EARLY ON STATION
- NEARLY ONE-HALF EXPERIMENTS ARE CANDIDATE FOR PRE-CURSOR SHUTTLE MANIFESTING

RECOMMENDATIONS

- MANNED SYSTEM EXPERIMENTS ARE NEEDED FOR STATION FLIGHT CREW OPERATIONS SUPPORT AND/OR ENHANCEMENT /PRODUCTIVITY
- EARLY TECHNOLOGY IMPLEMENTATION FUNDING REQUIRED TO MEET STATION IOC

SPACE TEST AND EVALUATION FACILITY

Douglas L. CHRISTENSEN

OBJECTIVE

PROVIDE FACILITIES TO ACCOMMODATE ORBITAL TESTING OF ADVANCED DEVELOPMENT AND TECHNOLOGY DEVELOPMENT EXPERIMENTS (STRUCTURES, MATERIALS, COMPONENTS, SYSTEMS)

DESCRIPTION

FLEXIBLE DESIGN WILL ALLOW VARIETY OF TEST ACCOMMODATIONS, MISSIONS AND EXPERIMENTS.
CONCEPTS INCLUDE ORBITER AND SPACE STATION ATTACHED, AND FREE FLYER MODES TO MEET COMMON REQUIREMENTS OF VARIOUS FLIGHT TEST MISSIONS.

SPACE TEST AND EVALUATION FACILITY

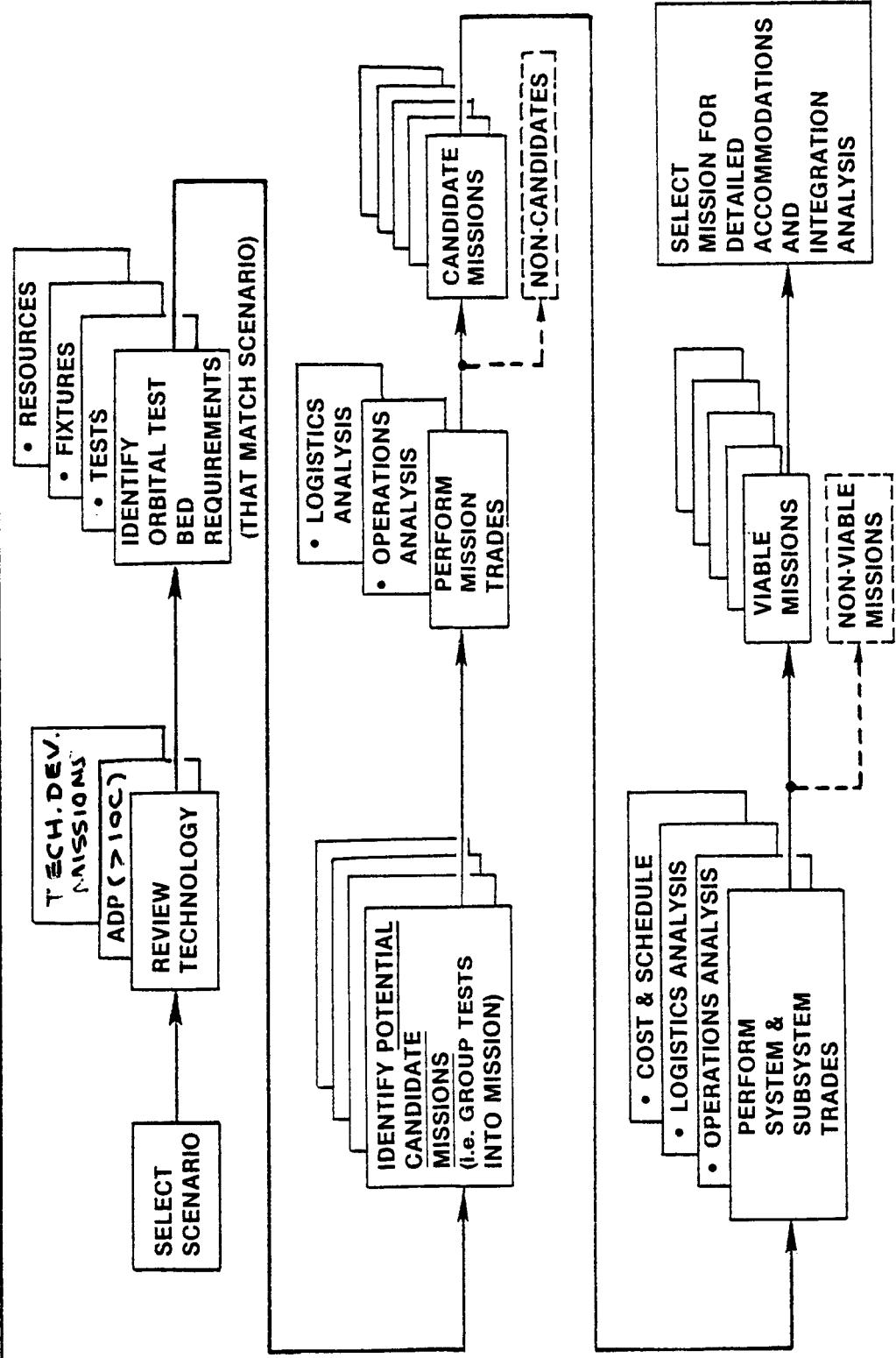
ACCOMMODATION REQUIREMENTS

TEST FACILITIES ARE BASED ON MISSION REQUIREMENTS FOR ADP AND TDM
AND THEIR SPECIFIC NEEDS/PRIORITIES

- o ATTACHED VERSUS FREE FLYER
- o PRESSURIZED VERSUS UNPRESSURIZED
- o SIZE, POWER, SERVICING, ETC.
- o COMMON REQUIREMENTS ANALYSIS
- o MISSION ANALYSIS

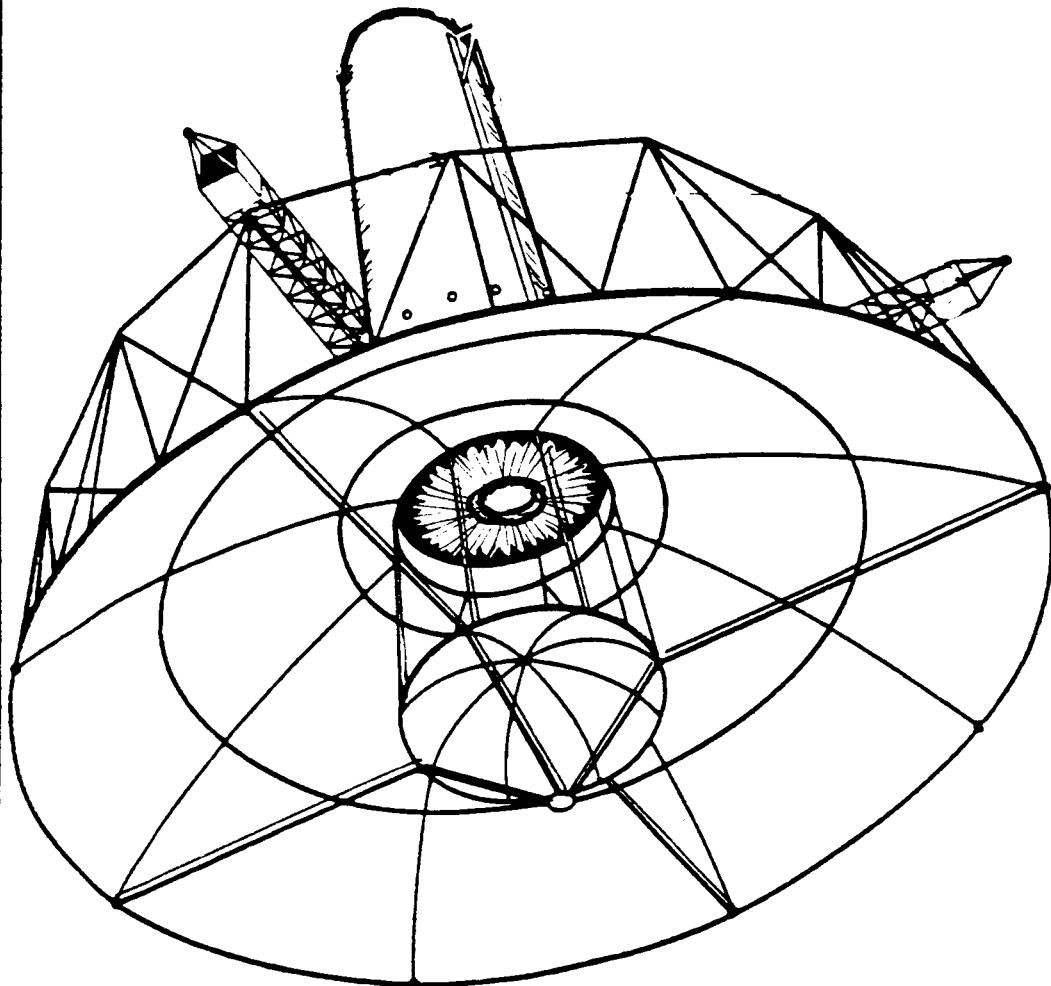
EACH STEF CONFIGURATION CAN ACCOMMODATE MULTIPLE EXPERIMENTS HAVING
COMMON RESOURCE REQUIREMENTS. SCENARIOS WILL BE DEVELOPED TO HELP
SELECT OPTIMUM DESIGN CONFIGURATIONS.

STEF PROGRAM FLOW DIAGRAM



SCENARIO FOR TYPICAL COMBINED TEST-BED
(SOLAR ENERGY TEST FACILITY - TDM 2153)

- COMPONENTS
- MATERIALS
 - PERFORMANCE
 - HEAT RECEIVERS
 - INSTRUMENTS,
 - CONTROLS



110

- HEAT REJECTION
- RAD. TECH. (TDM 2131)
 - ADV. RAD. (TDM 2132)
- ENERGY STORAGE (TDM 2151)
- ELECTROLYSIS
 - INERTIAL
- ENERGY CONVERSION
- ADV. STIRLING CYCLE
 - TRANSIENT ANALYSIS
 - LONG TERM DEMOS.
- APPLICATIONS
- SOLAR PUMPED LASER (TDM 2121)
 - LASER/ELEC. (TDM 2122)
 - LASER PROPULSION (TDM 2322)
 - DIRECT SOLAR THERMAL FURN.
 - WAKE SHIELD TECH.
 - MICROWAVE POWER GEN.
 - SPACE MIRROR TECH.
 - MATERIALS PROCESSING

- CONCENTRATORS
- DEPLOY/TEST (TDM 2111)
 - ENV. EXPOSURE (TDM 2511)
 - COATINGS/REFURB. (TDM 2564)

VARIABLE GRAVITY EXPERIMENT FACILITY

RICHARD J. WILLIAMS

SN12

NASA-JSC

OBJECTIVE:

TO USE THE SPACE STATION ENVIRONMENT TO PROVIDE ACCESS TO A CONTROLLED, VARIABLE GRAVITY ENVIRONMENT IN ORDER TO:

- A) DETERMINE THE FUNCTIONAL RELATIONSHIP BETWEEN GRAVITY AND VARIOUS PHYSICAL, CHEMICAL, AND BIOLOGICAL PROCESSES.
- B) REPLICATE THE SURFACE AND INTERIOR CONDITIONS OF VARIOUS PLANETS, ASTEROIDS, AND COMETS AND THUS SIMULATE THE PROCESSES OCCURRING ON OR IN THEM.
- C) STUDY VARIOUS RESOURCE UTILIZATION PROCESSES - E.G., MINERAL SEPARATION, FLUIDIZED BED REACTORS, EXTRACTION, FORMING - UNDER SIMULATED LUNAR, MARTIAN, OR ASTEROIDAL CONDITIONS.
- D) STUDY CELSS AND RELATED TECHNOLOGIES UNDER LUNAR OR MARTIAN CONDITIONS.

DESCRIPTION:

THE "EXPERIMENT" IS PROBABLY A MODULE, OR TETHERED PAIR OF MODULES, WHICH CAN BE ROTATED TO PRODUCE A PSEUDOGRAVITY WITH MINIMAL CORIOLIS FORCES OVER METER SCALES. THE ROTATION RATE WILL HAVE TO BE VARIABLE IN ORDER TO PRODUCE G'S BETWEEN 10^{-4} AND 0.3. THE MODULE WOULD BE EQUIPPED AS A LABORATORY WITH THE TEST AND SUPPORT EQUIPMENT NECESSARY TO SUPPORT INVESTIGATIONS IN A VARIETY OF DISCIPLINES - E.G., HIGH TEMPERATURE FURNACES, VACUUM CHAMBER, ANIMAL CAGES, PLANT CHAMBERS, MINERAL SEPARATION EQUIPMENT, IMPACT CHAMBER AND GUNS. SPECIFIC EQUIPMENT AND EXPERIMENTS WOULD HAVE SIGNIFICANT INHERITANCE FROM IOC EXPERIMENTS CURRENTLY PLANNED FOR THE MTL AND SLM.

IN OPERATION A GRAVITY LEVEL WOULD BE SELECTED FOR STUDY, THE MODULE ROTATED TO PRODUCE THE LEVEL, AND PROGRAM OF EXPERIMENTS (60 - 120 days) EXECUTED. AFTER PROGRAM WAS COMPLETED, OTHER G-LEVELS WOULD BE INVESTIGATED SIMILARLY.

VARIABLE GRAVITY EXPERIMENT FACILITY

FLIGHT DATE - 1997/98

OPERATION DAY - CONTINUOUS

MASS -

ESSENTIALLY EQUIVALENT TO

VOLUME -

ONE IOC LAB MODULE

AN INDEPENDENT MODULE FLYING IN FORMATION

ORIENTATION IS IMMATERIAL

EVA SET UP TBD

 OPERATIONS TBD

 SERVICING TBD

IVA SET UP TBD

 OPERATIONS TBD

 SERVICING TBD

POWER 60 KW

DATA RATE N/A

DATA STORAGE N/A

FLUIDIZED BED BEHAVIOR IN REDUCED GRAVITY

MICHAEL A. GIBSON AND CHRISTIAN W. KNUDSEN
CARBOTEK, INC.
HOUSTON, TEXAS

OBJECTIVE:

AVAILABILITY OF REDUCED, CONTROLLABLE GRAVITY IN A SPACE STATION COULD EXTEND THE APPLICABILITY OF FLUIDIZED BEDS TO MUCH LARGER OR DENSER SOLIDS THAN ARE USABLE ON EARTH.

THIS EXPERIMENT SEEKS TO MEASURE IMPORTANT FLUID-SOLIDS PARAMETERS AS FUNCTIONS OF GRAVITY; THESE DATA WILL BE NEEDED FOR SUBSEQUENT DESIGN OF SPACE STATION FLUIDIZED SOLIDS PROCESSING UNITS SUCH AS

- SOLIDS COATING REACTORS
- DRY POWDER MIXERS
- SOLID WASTE PROCESSORS

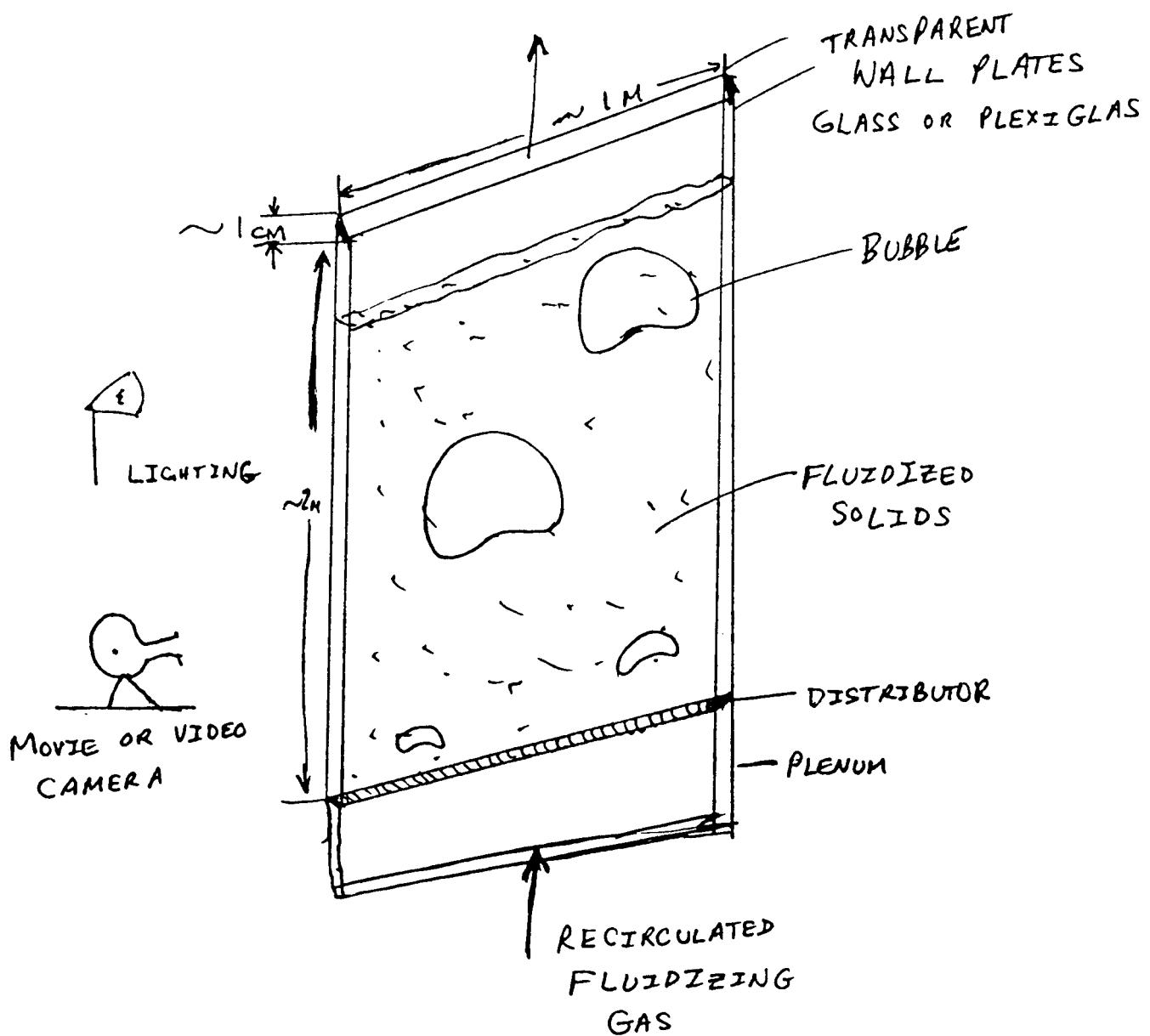
DESCRIPTION:

THE EXPERIMENT CONSISTS OF OPERATING A "TWO-DIMENSIONAL" FLUIDIZED BED WITH VARIOUS COMBINATIONS OF APPLIED GRAVITY, SOLIDS AND FLUIDIZING GAS. IN SUCH A THIN, TRANSPARENT VESSEL, THE CRUCIAL DESIGN PARAMETERS OF GAS BUBBLE SIZE, SHAPE AND GROWTH AND BED EXPANSION CAN BE OBSERVED DIRECTLY AND RECORDED ON FILM OR VIDEOTAPE. NUMEROUS 1g TERRESTRIAL EXPERIMENTS HAVE ESTABLISHED THE VALIDITY OF THIS TECHNIQUE FOR BUBBLE SIZE DETERMINATIONS.

THE ENTIRE EXPERIMENT CAN BE OPERATED AT ROOM TEMPERATURE. THE RANGE OF OTHER INDEPENDENT VARIABLES WOULD BE

- $0.01 < g < 0.3$
- MINIMUM FLUIDIZATION VELOCITY $< U_{mf}$ GAS VELOCITY $< U$ 90% OF TERMINAL VELOCITY (U_t)
- SOLIDS DIAMETERS UP TO 0.25 CM (2500μ)
- SOLIDS DENSITIES LIMITED ONLY BY $U > U_{mf}$

THE EXPERIMENT WOULD FIT LOGICALLY INTO THE PROPOSED VARIABLE GRAVITY EXPERIMENT FACILITY. IT WOULD NOT REQUIRE LONG-TERM OPERATION OR MONITORING. ONCE SET UP, THE BED FILLED WITH DESIRED SOLIDS AND THE DESIRED GRAVITY ESTABLISHED, ONLY A FEW MINUTES AT EACH CHOSEN GAS VELOCITY WOULD BE NEEDED FOR DATA ACQUISITION.



TWO-DIMENSIONAL, "COLD-MODEL" FLUIDIZED
VESSEL FOR SPACE STATION TESTING

EXPERIMENT TITLE: Fluidized Bed Behavior in Reduced Gravity

PROPOSED FLIGHT DATE - TBD YEAR

OPERATIONAL DAYS REQUIRED - Intermittent ~30 Total

MASS - 30 KG

VOLUME:

STORED: W 1 x L 2 x H 1 = 2 M³

DEPLOYED: W 1 x L 2 x H 1 = 2 M³

INTERNAL ATTACHED _____ (YES/NO)

EXTERNAL ATTACHED _____ (YES/NO)

FORMATION FLYING _____ (YES/NO)

ORIENTATION (inertial, solar, earth, other) N/A - None

EXTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: _____ Hrs/Day _____ No. of days

OPERATIONS: _____ Hrs/Day _____ No. of days _____ Interval

SERVICING: _____ Hrs/Day _____ No. of days _____ Interval

INTRA-VEHICULAR ACTIVITY REQUIRED:

SET-UP: 4 Hrs/Day 5-10 No. of days

OPERATIONS: 2 Hrs/Day 30 No. of days _____ Interval

SERVICING: 2 Hrs/Day 5 No. of days _____ Interval

POWER REQUIRED:

~1 KW AC or DC (circle one)

_____ Hrs/Day _____ No. of days

DATA RATE: N/A Megabits/second

DATA STORAGE: N/A Gigabits

SPACE STATION IN SITU TRACE CONTAMINANT ANALYSIS

Dr. Dana A. Brewer

Paul R. Yeager

NASA Langley Research Center

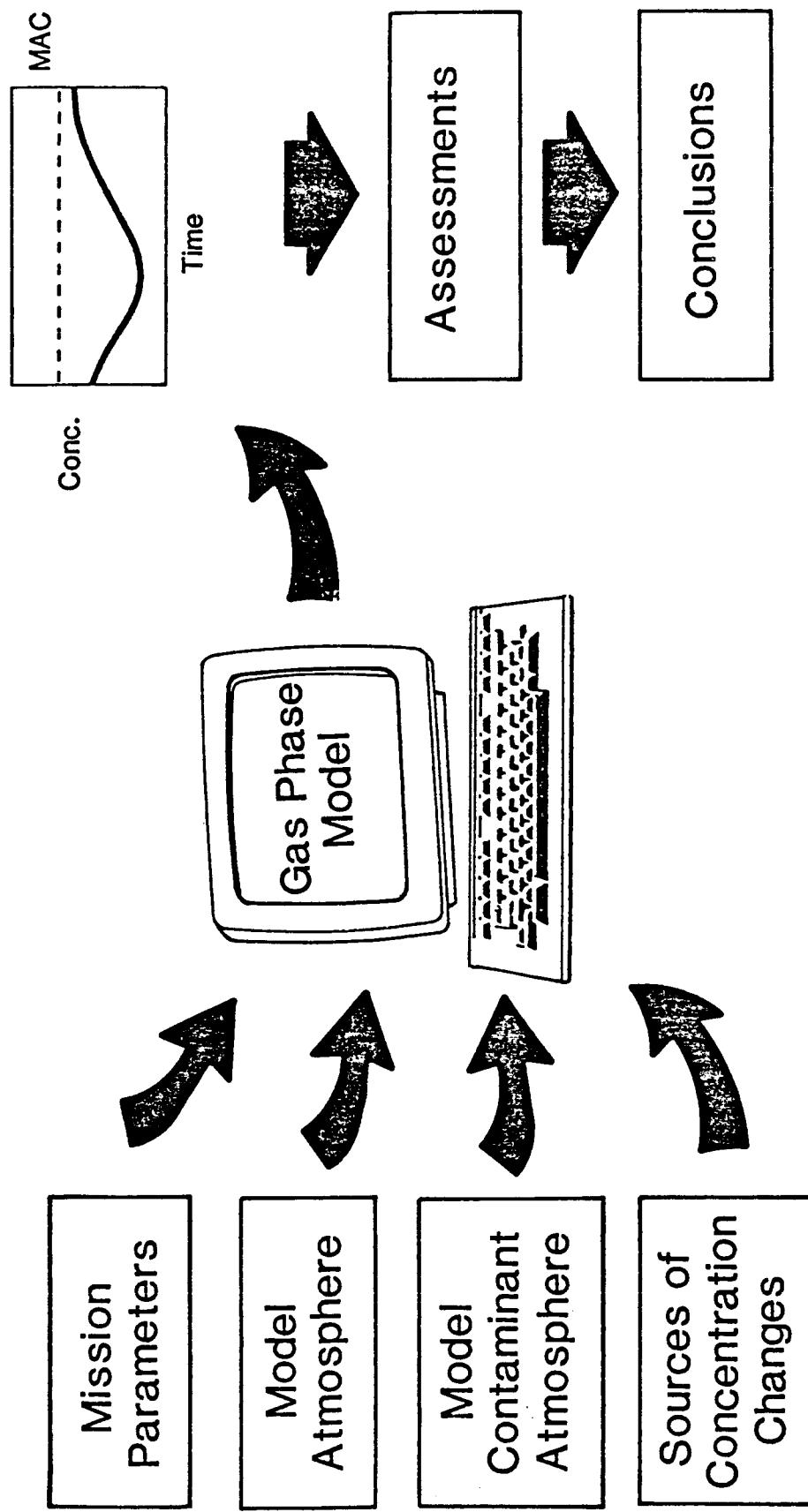
Presented at In-Space Research
Technology & Engineering Workshop

Williamsburg, VA

October 8–10, 1985

IN SITU TRACE CONTAMINANT ANALYSIS

Objective



How Can this Model be Validated so that It Provides a Realistic Representation of Changes in Trace Contaminant Concentrations as a Function of Time?

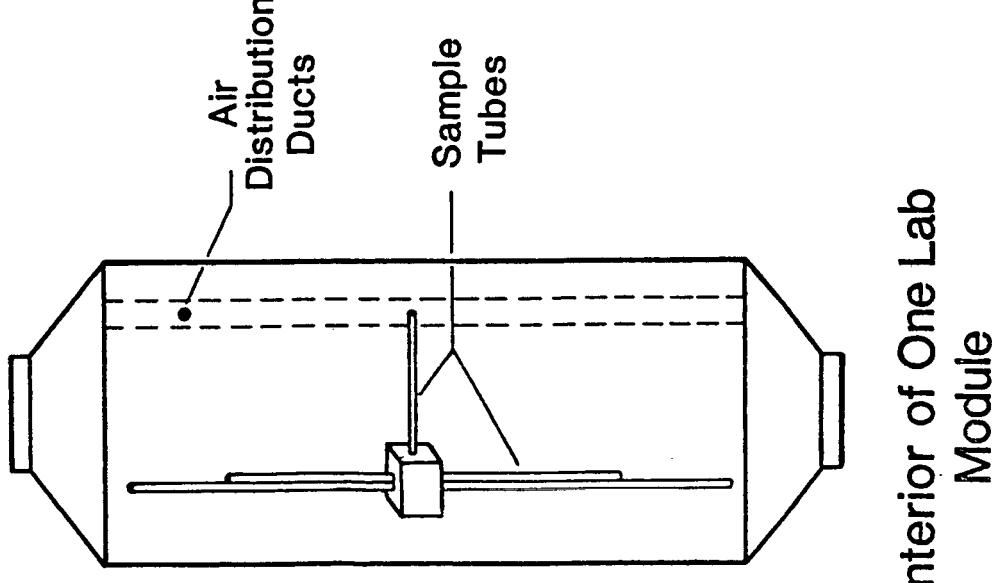
IN SITU TRACE CONTAMINANT ANALYSIS

Description

- Develop a Real-Time, On-Orbit System to Measure Trace Contaminant Concentrations in One Module of the Space Station
- Use Data to Validate Trace Contaminant Environmental Analysis Model
 - Does the Model Adequately Represent the Changes in Trace Constituents that Result from Chemical Reactions and Physical Sources and Sinks (Equipment Operation, Leakage, Metabolic Activity) in the Cabin Atmosphere?
 - Does the ECLSS Maintain a Safe Environment for the Crew?
 - Are Additional Controls and Monitoring Required for Long-Term Space Habitability?
- Use the Validated Model to Determine:
 - New Spacecraft Maximum Allowable Concentrations (SMAC's) for Missions of Long Duration
 - Impact of Commercial Experiments on Cabin Air
 - Growth Requirements of ECLSS for Evolutionary Space Stations

IN SITU TRACE CONTAMINANT ANALYSIS

EXPERIMENT DESIGN



- 5 Sampling Sites
 - One in Air Distribution Duct
 - Two in Interior of Module
 - Two at Ends of Module
- Real-Time, On-Orbit Measurements of:
 - Key Hydrocarbons
 - NO, NO₂, O₃
 - Aldehydes
 - Freons
- Chemical Analysis of Particulates
- Size Distribution and Gross Number of Particulates

IN SITU TRACE CONTAMINANT ANALYSIS

DATA ANALYSIS

- Correlate In Situ Measurements with
 - Chemical Analysis of Particulates
 - Analysis of Charcoal Filters
 - Flight Manifest (i.e., Experiment Initiation/Termination)
- Use Measurements to Validate Model
 - Are Additional Reactions Required in the Model?
 - Is the ECLSS Operating Efficiently?
 - Are Additional Filters Required?
 - Are Toxicological Hazards Present from Experiments?
- How will Future Experiments Impact the Cabin Air?
- What are the Growth Requirements of the ECLSS for Evolutionary Space Stations?

IN SITU TRACE CONTAMINANT ANALYSIS ACCOMMODATION REQUIREMENTS

- Proposed Flight Date 1992
- Operational Days Required 90
- Volume 0.379 m³
- Mass 113.4 kg
- Internally Attached Payload
- Fully Automated Data Collection
- Servicing in 90 Day Period 1 hour
- Power Required 24 hrs/day for 90 Day Mission 1.5 kW
- Type of Power Either AC or DC
- Frequency of Data Transmission Once a Day
- Rate of Data Transmission 1 Megabit/sec for 10 sec
- Data Storage for 1 Day of Data 0.1 Gigabits

AUTOMATIC SATELLITE CHECKOUT EQUIPMENT

BY

JOHN A. SCHROEDER

ROCKWELL INTERNATIONAL CORPORATION

10/05/85



1

*Summary only...
Refers to race paper submitted*

INTRODUCTION

SATELLITE CHECKOUT EQUIPMENT AS A TECHNOLOGY
AND ENGINEERING ACTIVITY FOR 1985 AND BEYOND

THEME: IN-SPACE OPERATIONS
SUB-TOPIC: SYSTEM TESTING



DEFINITION: SATELLITE CHECKOUT EQUIPMENT (SCE) :

AUTOMATIC TEST EQUIPMENT USED ON-ORBIT AND ON EARTH FOR
THE FUNCTIONAL TEST AND DIAGNOSIS OF SATELLITES AND
ORBITAL REPLACEABLE UNITS (ORUS OR SUB-ASSEMBLIES)

INTRODUCTION

- SATELLITE TECHNOLOGY IS MOVING RAPIDLY.
- SATELLITES ARE PROLIFERATING IN NUMBERS.
- COSTS ARE VERY HIGH.
- TEST AND MAINTENANCE SCENARIOS ARE FAR BEHIND.

THE NEED FOR SATELLITE CHECKOUT EQUIPMENT

- SATELLITES COSTING OVER \$50 MILLION HAVE FAILED IMMEDIATELY AFTER DEPLOYMENT.
- MODULAR SATELLITE CONSTRUCTION IS LEADING TO ON-ORBIT MAINTENANCE AND REPAIR.
- ON-ORBIT ASSEMBLY IS COMING SOON.

LOCATIONS OF VEHICLES & SATELLITES
(NAUTICAL MILES ALTITUDE)

SPACE STATION	270
ORBITER	150 - 270
LOW ALTITUDE SATELLITES	150 - 1000
GEOSYNCHRONOUS SATELLITES	2350
ORBITAL MANEUVERING VEHICLE (FROM ORBITER OR SPACE STATION)	150 - 1000
HIGH ALTITUDE PERMANENT OMV	2350

LOCATION OF NEEDED SCE

USES	GROUND	ORBITER	SPACE STATION	OMV
TEST DEVELOPMENT	X	X ⁽¹⁾	X ⁽¹⁾	
PRE-LAUNCH TEST	X	X		
PRE-DEPLOYMENT VERIFICATION		X	X	
FAILURE DIAGNOSIS	X	X	X	X
TEST AFTER MAINTENANCE/REPAIR	X	X	X	X ⁽¹⁾

(1) LIMITED CAPABILITY

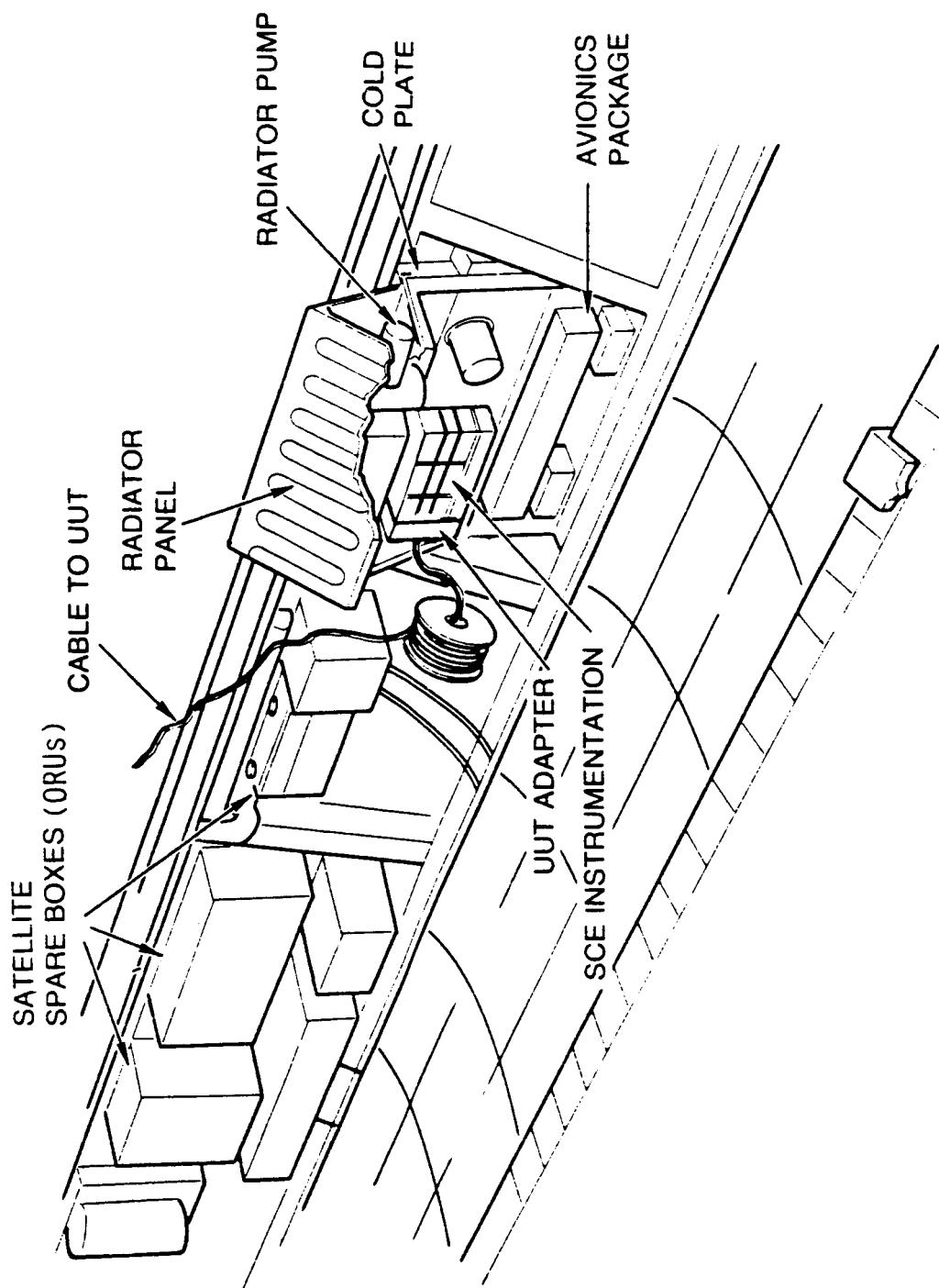
SCE REQUIREMENTS (1)

- SMALL SIZE & WEIGHT
- RADIATION SHIELDED
- LINKED VIA TELEMETRY
- MODULAR ARCHITECTURE FOR EVOLUTION & GROWTH
- HEATING/CABLING PACKAGING

SCE REQUIREMENTS (2)

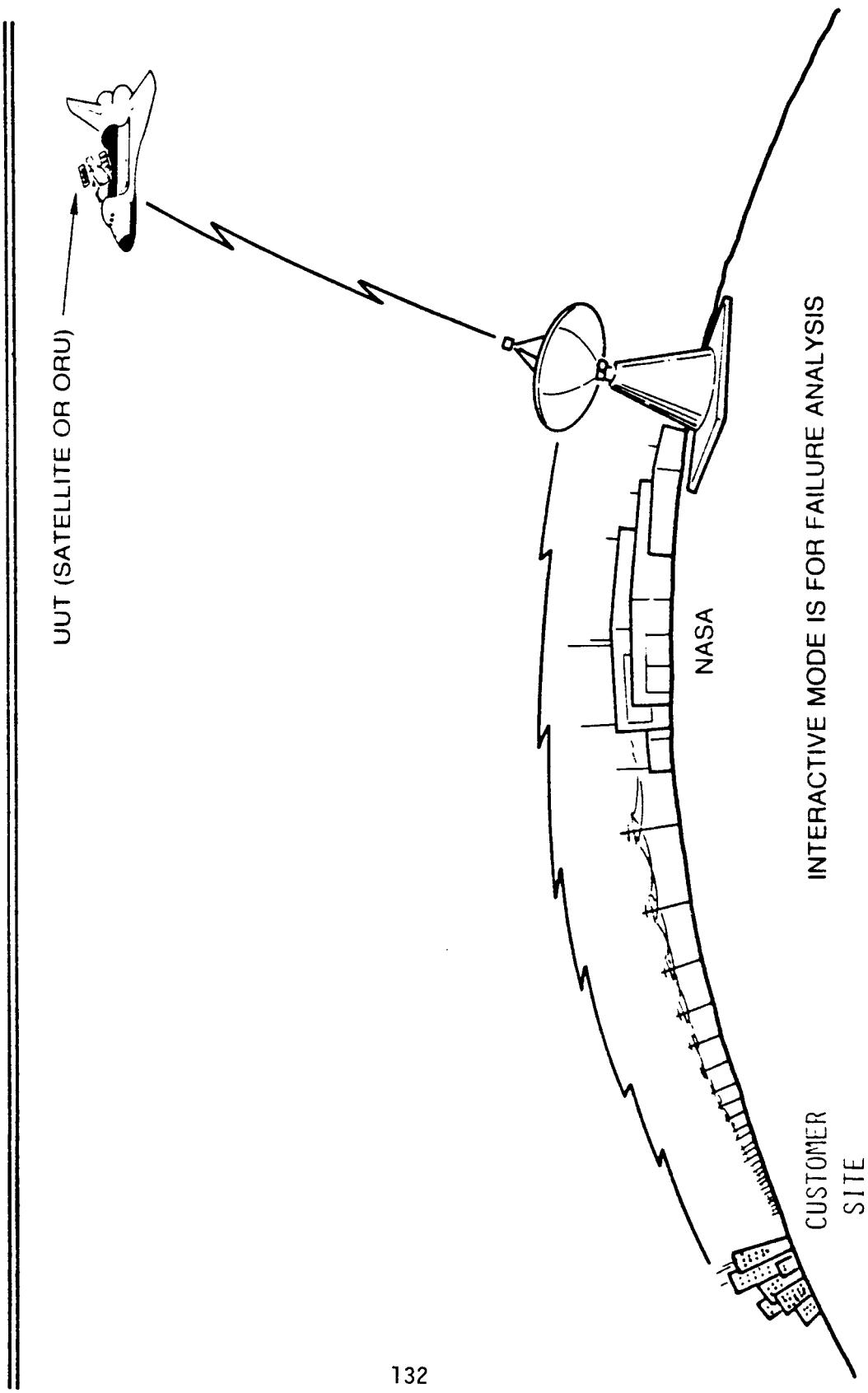
- PERFORMS OWN SELF TEST & CALIBRATION
- USES HIGH ORDER TEST LANGUAGE
- COMPATABLE HARDWARE AND SOFTWARE AMONG ALL SCE
- ADHERES TO ADAPTED AIR FORCE MATE REQUIREMENTS

ORBITER CARGO BAY INSTALLATION



 Rockwell International

SCE/GROUND COMMUNICATIONS



PRESENT STATUS

- SCE MANDATED FOR SPACE STATION
- NO DECISION FOR ORBITER
- NO DECISION FOR OMVs
- NO STANDARDS FOR SCE TO ASSURE COMPATIBILITY
- NO INTERFACE STANDARDS FOR SATELLITE DESIGNERS
- SCE TECHNOLOGY IS READY

SUMMARY

- SCE IS NEEDED FOR PRE-LAUNCH VERIFICATION, PRE-DEPLOYMENT TEST, FAILURE DIAGNOSIS, AND TEST AFTER MAINTENANCE, OR ASSEMBLY.
- SCE TECHNOLOGY IS READY.
- NASA INVOLVEMENT IS NEEDED TO HELP PLAN AND STANDARDIZE SCE.
- ROCKWELL INTERNATIONAL CORPORATION'S WORK IN SATELLITE SUPPORT EQUIPMENT, SPACE TRANSPORTATION, TELEMETRY AND ATE COMBINE TO FOCUS ON THE NEED FOR AND DESIGN OF SATELLITE CHECKOUT EQUIPMENT.

LARRY A. JONES
AFWAL

Project Title: Proposed Escape and Recovery Experiments on the Space Station.

Objective: To explore the feasibility of escape and recovery from a space station, using a multipurpose research vehicle and the OMV for deorbit, upper atmosphere penetration, and return to orbit scenario testing.

Technical Description: The program would consist of an initial analytical phase followed by the fabrication of a new capsule or refurbishment of an existing capsule and conversion of the capsule into a research vehicle for space escape and upper atmospheric variable density studies.

- o Develop scenarios for escape from future military space stations.
- o Establish requirements for a research capsule based on above scenarios.
- o Conduct trade study of candidate capsules.
- o Acquire or manufacture selected capsule.
- o Conduct initial space testing to include separation, re-entry, return to orbit, and redocking with the space station.
- o Acquire re-entry data and atmospheric properties.
- o Acquire and analyze data on control requirements, life support systems, ingress and egress.
- o Analysis of data from research capsule would be used to develop requirements for advanced escape capsule for future space stations.
- o Leave research capsule docked to space station upon completion of testing to serve as a functional emergency recovery vehicle for the space station crew.

Mission Date/Duration: Mission date would be approximatley 1995. Approximately 20 tests would be envisioned over a period of one year.

Mission/Function/System/Requirements: Escape systems used in the Air Force historically have been autonomous in operation since they are only activated when a malfunction or emergency occurs. Consequently, the experiments related to the research capsule would be somewhat unrelated to other activities on the space station. The space station would need to provide docking, data transmitting and recording, refurbishment storage, and crew monitoring facilities.

Scope: The use of an escape capsule, or capsules, for emergency escape from a space station is an attractive option for military related operations. The development of such a capsule system using the latest technologies in structures, crew accommodation, control and recovery is obviously an expensive effort. The successful implementation of an escape system would involve a complex threat assessment and failure mode analysis of the parent vehicle to direct evacuation and recovery notification to the space station crew. The utilization of artificial intelligent/expert systems would seem most appropriate to the final design of an operational space escape system. It is proposed that the escape and recovery experiments for the space station be primarily limited to the basic hardware testing and data acquisition experienced during recovery scenarios. It is proposed that an escape capsule be selected from a candidate list including a state of the art design or updated versions of either the Mercury, Gemini, or Apollo capsules. The selected system would be used as a research tool on the space station to acquire valuable experimental data to be used in defining the requirements for a future military operational escape capsule system. The research capsule would explore the escape mission scenario including separation from a space station, maneuvering into a desired trajectory, firing of retro-rockets, re-entry into the upper atmosphere for data collection of regions of variable density phenomenon followed by a boost from the OMV for orbit insertion and return to the space station. Research missions could include orienting the capsule in space to use the heat shield to protect the capsule from simulated lasers or directed energy weapons and maneuvers in space and during re-entry to avoid enemy defenses and territory. The research crew could vary from one astronaut to perhaps as many as eight to ten. Integration of minimum requirements for life support systems into the short duration mission would be included. While the existing capsules have automatic control for re-entry, the selected version of the research capsule would investigate the level of manual control which could be tolerated in order to reduce the complexities and constraints of an advanced capsule system.

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